



A Review of NASA

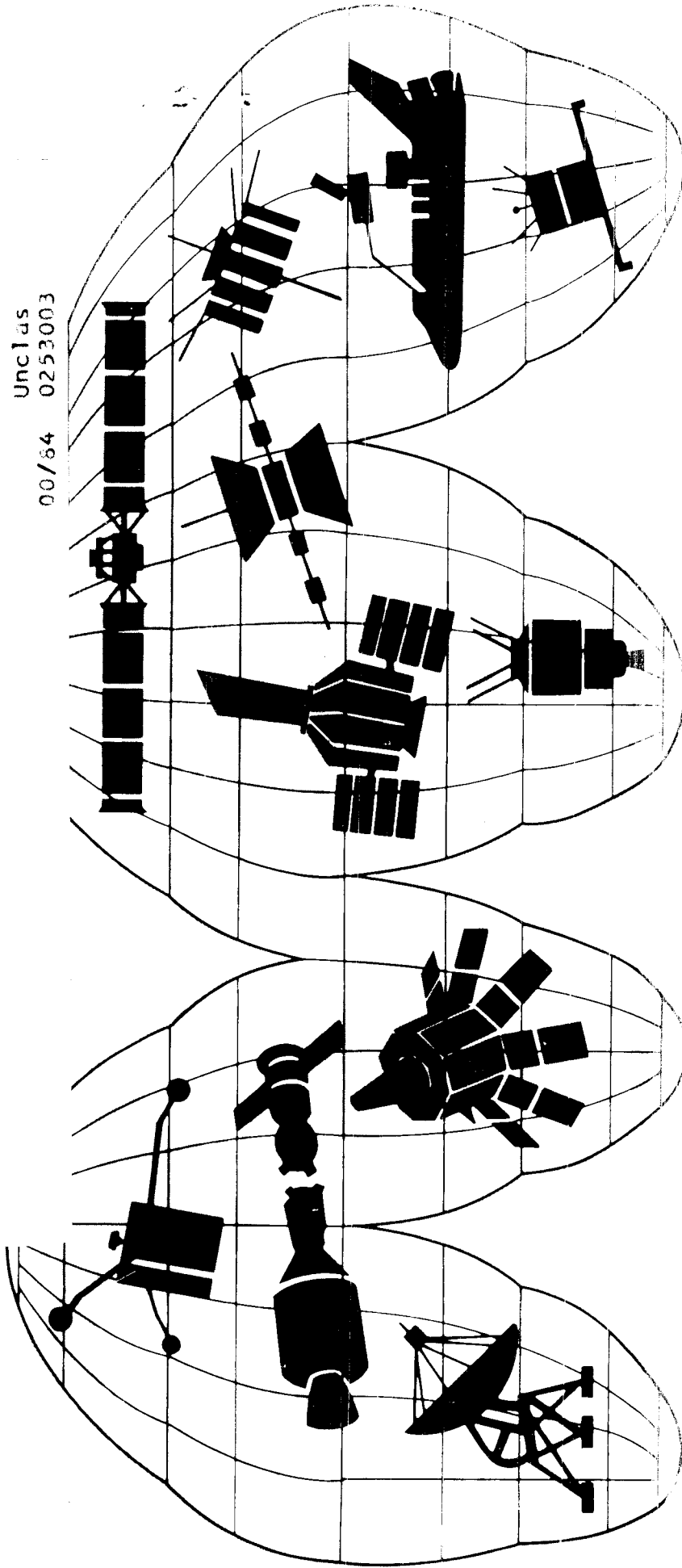
National Aeronautics and  
Space Administration

# International Programs

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**A review of  
NASA INTERNATIONAL PROGRAMS**

**Prepared by  
The Staff of the International Affairs Division  
NASA Headquarters  
Washington, D.C.**

## **Foreword**

During the twenty years of its existence, NASA has developed an extensive program of international cooperation involving more than 100 countries, developing as well as industrialized, in a variety of scientific and technical activities. International cooperation is an important, constructive dimension of the United States space program and has helped NASA to meet the challenges of space exploration and to harness the benefits of space for mankind. The relationships established to carry out the activities described in this booklet provide a basis for continuing and expanding international cooperation in the 1980's and beyond.

**Kenneth S. Pedersen**  
Director of International Affairs

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## Introduction

NASA, under the mandate given it by the 1958 National Aeronautics and Space Act "may engage in a program of international cooperation in work done pursuant to this Act, and in the peaceful application of the results thereof..." Pursuant to this Act, NASA has developed an extensive program of international cooperation which has opened the entire range of its space activities to foreign participation. NASA's international activities demonstrate the many peaceful purposes and applications of space science and technology and provide opportunities for contribution by scientists and agencies of other countries to the tasks of increasing human understanding and use of space environment. Cooperation also supports operating requirements for the launching and observation of spacecraft.

Cooperation by the United States (US) with other nations contributes to the US aeronautical and space research program and to broader national objectives by

- Stimulating scientific and technical contributions from abroad
- Enlarging the potential for the development of the state of the art
- Providing access to foreign areas of geographic significance for measurements of space flights
- Enhancing satellite experiments by foreign ground-support programs
- Developing cost-sharing and complementary space programs
- Extending ties among scientific and national communities
- Supporting US foreign relations and foreign policy

Cooperative activities have ranged from flight of foreign built spacecraft to ground-based study and analysis of data. Activities include, for example, contributions of experiments or payloads to be flown in space by NASA, joint projects to develop flight hardware, use of data or lunar samples provided by NASA satellites, training, visits, and joint publication of scientific results. In addition, NASA provides on a reimbursable basis certain services, including launching satellites and data and tracking services. Cooperative programs and activities involving nations and groups of nations are established by (1) agency to agency memoranda of understanding (MOU's), (2) agency to agency letter agreements, or (3) more formal intergovernmental agreements. The relative complexity, cost, and duration of the program or project dictate in part the type of arrangement used to establish the cooperative effort.

NASA's international activities follow guidelines which recognize the interests of the US and foreign scientists, establish a basis for sound programs of mutual value, and contribute substantively to the objectives of international cooperation. These guidelines provide for

- Designation by each participating government of a central civilian agency for the negotiation and supervision of joint efforts
- Conduct of projects and activities having scientific validity and mutual interest
- Agreement upon specific projects rather than generalized programs
- Acceptance of financial responsibility by each participating agency for its own contributions to joint projects
- Provision for the widest and most practicable dissemination of the results of cooperative activities

This booklet provides a synoptic overview of the main activities to date and identifies the cooperating countries and institutions which have been involved in NASA's international activities. It was prepared by the staff of the International Affairs Division, NASA Headquarters. To aid the reader and to increase the usefulness of the publication, measurement values are given in both SI and U.S. Customary Units and a list of commonly used acronyms and abbreviations is included as an appendix. Comments and suggestions for improvement, as well as requests for additional copies, should be directed to:

International Affairs Division  
Code LI-15  
NASA Headquarters  
Washington, DC 20546

# Cumulative Statistical Summary Through January 1, 1981

	Number Countries/ International Organizations	Number Projects/ Investigations/Actions Completed or in Progress As of January 1, 1981	Number Countries/ International Organizations	Number Projects/ Investigations/Actions Completed or in Progress As of January 1, 1981
<b>COOPERATIVE ARRANGEMENTS</b>				
Cooperative Spacecraft Projects	8	36		
Experiments on NASA Spacecraft				
Experiments with Foreign				
Principal Investigators	14	72		86
US Experiments with Foreign Co-				
Investigators or Team Members	11	59		
US Experiments on Foreign Spacecraft	3	6		4
Cooperative Sounding Rocket	22	1,764***		
Projects				
Joint Development Projects	4	7		
Cooperative Ground-Based Projects				
Remote Sensing	53	162		
Communication Satellite	51	18		47
Meteorological Satellite	44	9	20	
Geodynamics	41	14	15	20
Space Plasma	38	5		
Atmospheric Study	15	11		42
Support of Manned Space Flights	21	2	5	12
Support of Planetary Flights	5	6	3	
Astronomy and Astrophysics	24	10		
Cooperative Balloon and Airborne				
Projects				
Balloon Flights	8	8		1,151
Airborne Observations	12	19	45	
Cooperative Aeronautical Projects	5	31	21	358
US/USSR Coordinated Space Projects	1	9	21	955
US/China Space Projects	1	3	128	75,890
Scientific and Technical Information	70	3		
Exchanges				
<b>TRACKING AND DATA ACQUISITION</b>				
NASA Overseas Tracking Stations/ Facilities				
NASA Funded SAO Optical and Laser Tracking Facilities				
Reimbursable Tracking Arrangements				
Support Provided by NASA				
Support Received by NASA				
<b>PERSONNEL EXCHANGES</b>				
Resident Research Associateships				
International Fellowships				
Technical Training				
Foreign Visitors				

\* AIDSAT Demonstrations

\*\* APT Stations

\*\*\* Number of Actual Launches

NASA INTERNATIONAL PROGRAMS

## Cooperative Spacecraft Projects

Country, Name, Launch Site, & Date	Vehicle & Orbit	Spacecraft Responsibility	Experimenter's Affiliation	Experiment Description
CANADA				
o Alouette-I Western Test Range (WTR) Sep. 29, 1962	Thor-Agena B 1000 km Circular Near Polar	Defense Research Telecommunications Establishment (DRTE)	DRTE	Sound ionosphere from above (topside sounder) to measure its hour-to-hour electron densities.  Determine electron density at height of satellite.  Monitor very low frequency (VLF) noise in range of 1 to 10 kilocycles/sec.  Measure primary cosmic ray particles outside the Earth's atmosphere.
o Alouette-II WTR Nov. 29, 1965	Thor-Agena B 500-3000 km Near Polar	DRTE	National Research Council of Canada (NRCC)  DRTE/NRCC	Same Canadian experiments as Alouette-I.
o International Satellite for Ionospheric Studies (ISIS-I) WTR Jan. 30, 1969	Improved Delta 500-3500 km Polar	DRTE	NASA Goddard Space Flight Center (GSFC)  DRTE	Determine electron temperature in vicinity of orbiting spacecraft.  Swept- and fixed-frequency topside sounders supplemented by eight additional experiments, four Canadian and four United States (US).
o ISIS-II WTR Mar. 31, 1971	Improved Delta 1400 km Circular Near Polar	Communications Research Center (CRC), formerly DRTE, Department of Communications	CRC	Swept- and fixed-frequency topside sounders supplemented by ten additional experiments, six Canadian and four US.

o Completed Project  
• Current

## Cooperative Spacecraft Projects

Country, Name, Launch Site, & Date	Vehicle & Orbit	Spacecraft Responsibility	Experimenter's Affiliation	Experiment Description
CANADA (Continued)				
o Communications Technology Satellite (CTS) Eastern Test Range (ETR) <u>Jan. 13, 1976</u>	Delta Equatorial Synchronous	CRC	CRC/NASA Lewis Research Center (LeRC)	Communication and broadcasting satellite transmitting in 12 GHz band at high power levels to small terminals. Design, development and operation provided by CRC; 20 W traveling wave tube (TWT) provided by ESA; 200 W TWT and launch provided by NASA. Satellite time shared by US and Canada for broadcast experiments in education, health care, community and special services, and communications technology.
EUROPEAN SPACE AGENCY (ESA); formerly ESRO*				
o International Radiation Investigation Satellite (IRIS) (ESRO-II) WTR <u>May 17, 1968</u>	Scout 320-870 km Near Polar	ESRO - France  - Netherlands - United Kingdom (UK)	Center for Nuclear Studies, National Center for Scientific Research (CNRS) Utrecht Observatory University of Leeds University of Leicester University College, London	Integrated study of solar radiation and cosmic rays.
o Aurorae (ESRO-I) WTR <u>Oct. 3, 1968</u>	Scout 260-1490 km Near Polar	ESRO - Denmark - Norway - Sweden - UK	Royal Technical University University of Oslo Kiruna Geophysical Observatory Queen's University, Belfast Radio and Space Research Station, Slough	Integrated study of high latitude energetic particles and their effects on the ionosphere.

\*European Space Research Organization - hereinafter shown as ESA

## Cooperative Spacecraft Projects

Country, Name, Launch Site, & Date	Vehicle & Orbit	Spacecraft Responsibility	Experimenter's Affiliation	Experiment Description
EUROPEAN SPACE AGENCY (Continued)				
Aurorae (Continued)				
• International Sun-Earth Explorer-2 (ISEE-2) ETR Oct. 22, 1977	Delta 280-138,000 km Low Inclination	UK  ESA - France - Italy	University College, London (2 experiments)	ESA is providing daughter (ISEE-2) spacecraft to the project consisting of three coordinated spacecraft to study magnetosphere, interplanetary space, and their interaction.
• International Ultraviolet Explorer Satellite (IUE) ETR Jan. 26, 1978	Delta Low Inclination Geosynchronous	GSFC/European Space Technology Center (ESTEC)/ Culham Laboratory, UK	Paris Observatory University of Rome (ISEE-2 only)	US/ESA/UK tripartite agreement: ESA provides essential hardware and ground support for the spacecraft and telescope, which will study ultraviolet (UV) spectroscopy of stellar objects, gas clouds, planets, and comets.
• Spacelab-1 Kennedy Space Center (KSC) 1983	Space Shuttle Low Earth Orbit	ESA/NASA	Mission Managed by NASA Marshall Space Flight Center (MSFC)	Multidisciplinary mission involving over 70 experiments and 200 investigators from 16 countries. Experiments will be conducted in stratospheric and upper atmospheric research, materials processing, plasma physics, biology, botany, medicine, astronomy, solar physics, and in technology areas such as thermodynamics and lubrication.
• Space Telescope (ST) KSC 1983	Space Shuttle 500 km Circular	MSFC	(1) ESTEC (2) European Faint Object Camera Team includes scientists from: Austria, Belgium, Chile, France, Italy, Netherlands, UK, US	ESA is contributing to the NASA ST project: (1) the ST Solar Array; (2) one of four focal plane instruments, the Faint Object Camera, with photon event counter detector to operate in the wavelength range 120-800 nm; and (3) scientific and engineering ground operations support. ESA-sponsored astronomers will receive roughly 15% of the ST observing time.

## Cooperative Spacecraft Projects

Country, Name, Launch Site, & Date	Vehicle & Orbit	Spacecraft Responsibility	Experimenter's Affiliation	Experiment Description
EUROPEAN SPACE AGENCY (Continued)				
• International Solar Polar Mission (ISPM), NASA/ESA Dual Spacecraft Mission ETR 1985	Shuttle Planetary Out-of-Ecliptic	ESA/Jet Propulsion Laboratory (JPL)	Foreign Investigations provided by: France, Germany, Italy, Switzerland	ESA and NASA each are providing one of the two ISPM spacecraft to journey out of the ecliptic plane of the solar system to conduct coordinated observations of the interplanetary medium and the Sun simultaneously or stereoscopically, in the northern and southern hemispheres of the inner solar system.
FRANCE				
o FR-1 WTR Dec. 6, 1965	Scout 750 km Circular Near Polar	National Center for Space Studies (CNES)	National Center for Telecommunications Studies (CNET)	Simultaneously measure the electric and magnetic components of VLF radio emissions and measure electron densities.
o Eole Wallops Island Aug. 16, 1971	Scout 680-900 km Mid Inclination	CNES	Aeronomy Service, CNRS/National Meteorological Service/CNES	Determine feasibility of a satellite/balloon system to gather meteorological data on a global scale. Tests included satellite location and interrogation of instrumented balloons drifting at a constant level in the Southern Hemisphere.
GERMANY*				
o AZUR WTR Nov. 7, 1969	Scout 390-3150 km High Inclination	Federal Ministry for Scientific Research (BMWF)	Max Planck Institute (MPI), Munich University of Kiel MPI, Lindau	Measure proton energy spectrum and omnidirectional flux. Measure midrange energy spectrum of protons. Measure electrons above 40 KeV energy threshold and higher energy spectrum of protons.
*As used in this review, Germany refers to the Federal Republic of Germany unless otherwise indicated.				
NASA INTERNATIONAL PROGRAMS				

## Cooperative Spacecraft Projects

Country, Name, Launch Site, & Date	Vehicle & Orbit	Spacecraft Responsibility	Experimenter's Affiliation	Experiment Description
GERMANY (Continued)				
AZUR (Continued)				
o Barium Ion Cloud Probe Wallops Island Sep. 20, 1971	Scout Apogee 32,000 km	BMwF	Technical University of Braunschweig	Monitor satellite's axis with respect to geomag- netic field.
			Institute for Physics of the Atmosphere, Oberpfaffenhofen	Photometric observation of aurorae emissions at selected wavelengths.
			MPI, Munich/NASA Langley Research Center (LaRC)	Study the broad features of electric and magnetic fields in the magnetosphere: test the validity of barium release technique as a means of simula- tion of the interaction of the solar wind with an ionized comet trail, and study the behavior of an ion cloud in a collisionless plasma.
o AEROS WTR Dec. 16, 1972	Scout 220-860 km High Inclination	BMwF	MPI, Heidelberg	Measure number, density, and composition of neutral and ionized components; correlate data with solar extreme ultraviolet (EUV) measurements.
			Fraunhofer Institute, Freiburg	Measure energy distribution of electrons and ions, total and local ion densities.
			Ionospheric Institute, Breisach	Measure solar EUV radiation and its variations.
			GSFC	Measure total neutral density.
oo Helios ETR (Two Flights) Dec. 10, 1974 Jan. 15, 1976	Titan-III/Centaur Heliocentric Perihelion Approx. 0.30 AU	BMwF	MPI, Munich/NASA Ames Research Center (ARC)	Measure low energy particle fluxes.
			Technical University of Braunschweig	Measure vector components of the magnetic field and magnetic fluctuations.

## Cooperative Spacecraft Projects

Country, Name, Launch Site, & Date	Vehicle & Orbit	Spacecraft Responsibility	Experimenter's Affiliation	Experiment Description
GERMANY (Continued)				
Helios (Continued)			University of Rome/GSFC	Measure vector components of the magnetic fields extending range of Braunschweig experiment.
			GSFC/University of Iowa/ University of Minnesota	Observe electrostatic and electromagnetic wave phenomena.
			University of Kiel	Measure protons and alpha particles.
			University of Adelaide/ GSFC	Measure protons and electrons. Monitor X-ray emission of Sun.
			MPI, Lindau	Detect and count electrons.
			Heidelberg State Observatory	Observe zodiacal light in white light and measure polarization.
			MPI, Heidelberg	Measure micrometeoroid flux.
			University of Hamburg/JPL	Test general relativity theory and study solar mass and orbital characteristics of the inner planets.
<ul style="list-style-type: none"> <li>Project Galileo, formerly Jupiter Orbiter Probe (JOP) KSC 1985</li> </ul>	Space Shuttle Planetary Trajectory	JPL	University of Bonn MPI, Heidelberg	Federal Ministry for Research and Technology (BMFT) is contributing to the NASA Project Galileo: (1) the Retro-Propulsion Module (RPM), bipropellant engines for mission maneuvers and insertion of the spacecraft into Jovian orbit; and (2) sponsorship for participation of 14 German scientists in science investigations.

## Cooperative Spacecraft Projects

Country, Name, Launch Site, & Date	Vehicle & Orbit	Spacecraft Responsibility	Experimenter's Affiliation	Experiment Description
ITALY				
o Project "San Marco" (Phase I) Wallops Island <u>Apr./Aug. 1963</u>	Shotput Sub- Orbital Launches (Tests)	Italian Space Commission		
o San Marco-I (Phase II) Wallops Island <u>Dec. 15, 1964</u>	Scout 200-800 km Near Equatorial Eccentric	Italian Space Commission	School of Aerospace Engineering, University of Rome	Determine local density of upper atmosphere (Phase II) and local density of equatorial upper atmosphere (Phase III) by measuring the instantane- ous aerodynamic drag on the respective satellites.
o San Marco-II (Phase III) San Marco Range* <u>Apr. 26, 1967</u>	Scout 220-800 km Near Equatorial Eccentric	Italian Space Commission	University of Florence	Ionospheric propagation studies (Faraday rotation technique) using beacon (Phase II and Phase III).
o San Marco-III San Marco Range <u>Apr. 24, 1971</u>	Scout 200-700 km Near Equatorial	Center for Aero- space Research (CRA), Univer- sity of Rome		Continue use of drag force balance to measure the local density of equatorial upper atmosphere by measuring the instantaneous aerodynamic drag on the satellite.
			GSFC	By means of mass spectrometry: (1) Measure directly the densities of molecular nitrogen, molecular oxygen, atomic oxygen, argon, and helium. (2) Measure directly the source density of molecular nitrogen.

\*Towable platform in Indian Ocean equatorial waters, University of Rome also responsible for launching Scout vehicle.

## Cooperative Spacecraft Projects

Country, Name, Launch Site, & Date	Vehicle & Orbit	Spacecraft Responsibility	Experimenter's Affiliation	Experiment Description
ITALY (Continued)				
o San Marco-III-2 San Marco Range Feb. 18, 1974	Scout 200-850 km Near Equatorial	CRA	CRA	Continue use of drag force balance to provide measurements of the diurnal variations of the equatorial neutral thermosphere density for correlation with simultaneous data on composition and temperature from NASA's Explorer-51 (Atmospheric Explorer-3).
			GSFC	Two mass spectrometers to measure directly the composition and temperature of the equatorial neutral thermosphere for correlation with data taken simultaneously on identical instrument on Explorer-51.
• San Marco-D/L San Marco Range 1982	Scout High Inclination Low Orbit	CRA	CRA	On low altitude spacecraft, continue use of drag force balance to measure equatorial neutral thermosphere density.
			GSFC	Use neutral mass spectrometer to measure neutral composition, temperature and solar winds; with electric field probe, study equatorial ionospheric phenomena near equatorial electrojet.
			Fraunhofer Institute, Freiburg	Airglow spectrometer to measure day and night airglow from low altitude spacecraft.
• San Marco D/M San Marco Range 1983	Scout Near Synchronous, Highly Elliptical Orbit	CRA	CRA	On high altitude "multistationary" spacecraft, use spinning infrared radiometer to obtain five-band measurement of ozone distribution.

## Cooperative Spacecraft Projects

Country, Name, Launch Site, & Date	Vehicle & Orbit	Spacecraft Responsibility	Experimenter's Affiliation	Experiment Description
NETHERLANDS				
o Astronomical Netherlands Satellite (ANS) WTR <u>Aug. 30, 1974</u>	Scout 500 km Near Polar	Netherlands Astronomy Satellite Program Authority (to 1970)/ Netherlands Agency for Aerospace Programs (NIVR)	Kapteyn Astronomical Observatory  Space Research Laboratory (SRL), Leige University, Utrecht  American Science and Engineering/Massachusetts Institute of Technology (MIT)	UV photometry.  Measure soft X-ray emissions.  Measure hard X-ray emissions.
• Infrared Astronomical Satellite (IRAS) WTR 1982	Delta 900 km Circular High Inclination	NIVR	(1) Universities of Groningen, Amsterdam, and Leiden, Nether- lands (2) University College, London, Queen Mary College, Royal Obser- vatory Greenwich, and Science Research Council (SRC), UK (3) JPL, ARC, GSFC, Cali- fornia Institute of Technology (CalTech), and Association of Universities in Astronomy, US	A Netherlands-built spacecraft with a cryogenically cooled infrared (IR) telescope (provided by NASA) with appropriate focal plane detectors for IR measurements in 4 bands from 8-120 . The objective is to produce an IR all- sky survey of discrete sources and publish results as a sky and source catalogue. UK SRC is providing the ground control and operating facility.

## Cooperative Spacecraft Projects

Country, Name, Launch Site, & Date	Vehicle & Orbit	Spacecraft Responsibility	Experimenter's Affiliation	Experiment Description
SPAIN				
o INTASAT WTR <u>Nov. 15, 1974</u>	Delta (Piggyback) 500 km Circular Mid Inclination	National Institute for Aerospace Technology (INTA)	INTA	Ionospheric beacon for synoptic study of the ionosphere by ground-base observations of radio signals transmitted from the satellite.
UNITED KINGDOM				
o Ariel-I ETR <u>Apr. 26, 1962</u>	Delta 360-770 km High Inclination	GSFC	Imperial College, London  University of Birmingham  University College, London	Measure spectrum of primary cosmic ray energies and its variations, with Cerenkov detector.  Measure local electron density with radio frequency impedance probe.  Measure electron temperature and density with Langmuir probe.  Measure ion mass composition and temperature with mass spectrometer.  Measure energy spectrum of solar hard X-rays.  Measure solar UV emissions (Lyman-Alpha).  Measure atmospheric ozone with filtered photo-cells and spectrometer.  Measure galactic radio noise.
o Ariel-II Wallops Island <u>Mar. 27, 1964</u>	Scout 480-590 km High Inclination	GSFC	Meteorological Office, UK Air Ministry  Mullard Radio Astronomy Observatory, University of Cambridge	

## Cooperative Spacecraft Projects

Country, Name, Launch Site, & Date	Vehicle & Orbit	Spacecraft Responsibility	Experimenter's Affiliation	Experiment Description
UNITED KINGDOM (Continued)				
Ariel-II (Continued)				
o Ariel-III WTR <u>May 5, 1967</u>	Scout 440-500 km High Inclination	Royal Aircraft Establishment, Farnborough	Nuffield Radio Astronomy Laboratories, Jodrell Bank	Measure micrometeoroid flux by optical detection of holes formed in a thin metallic film.
			Meteorological Office, UK Air Ministry	Measure vertical distribution of molecular oxygen in Earth's atmosphere.
			University of Manchester	Measure large-scale noise sources in galaxy.
			University of Sheffield	Measure intensity of VLF radiation.
			Radio and Space Research Station, Slough	Measure intensity and geographical distribution of sources of natural terrestrial noise.
			University of Birmingham	Measure electron density and temperature.
			University of Birmingham	Measure electron temperature.
o Ariel-IV WTR <u>Dec. 11, 1971</u>	Scout 480-490 km High Inclination	SRC	University of Sheffield/ Radio and Space Research Station, Slough	Measure VLF radiation and lightning discharge noise.
			Nuffield Radio Astronomy Laboratories, Jodrell Bank	Measure ionospheric and cosmic radio noise.
			University of Iowa	Measure low energy proton and electron intensities.
o Ariel-V San Marco Range <u>Oct. 15, 1974</u>	Scout 500 km Circular Low Inclination	SRC	Mullard Space Science Laboratory/University College, London/GSFC	Measurement of X-ray source positions and sky survey.

## Cooperative Spacecraft Projects

Country, Name, Launch Site, & Date	Vehicle & Orbit	Spacecraft Responsibility	Experimenter's Affiliation	Experiment Description
UNITED KINGDOM (Continued)				
Ariel-V (Continued)				
<ul style="list-style-type: none"> <li>International Ultraviolet Explorer Satellite (IUE) ETR Jan. 26, 1978</li> </ul>	Delta Low Inclination Geosynchronous	GSFC/ESTEC/ Culham Laboratory, UK	University of Leicester	Conduct sky survey and examine distribution of isotropic X-ray background.
			Mullard Space Science Laboratory/University College, London/GSFC	Study of the spectra of individual stellar X-ray sources utilizing proportional counter.
			University of Leicester	Examination of the radiation of X-ray sources by means of a scattering polarimeter.
			Imperial College, London	Study of high energy X-ray sources and identification of regular periodic pulsations in the X-ray flux with the periods of known pulsars.
			GSFC/Culham Laboratory, UK	US/UK/ESA tripartite agreement: UK provides essential hardware and ground support for the spacecraft and telescope, for study of UV spectroscopy of stellar objects, gas clouds, planets, and comets.

## Experiments on NASA Spacecraft

Country, Name, Launch Site, & Date	Vehicle & Orbit	Spacecraft Responsibility	Principal Experimenter's Affiliation	Experiment Description
EXPERIMENTS WITH FOREIGN PRINCIPAL INVESTIGATORS:				
BELGIUM				
o Skylab Eastern Test Range (ETR) May 14, 1973	Saturn 430 km Circular High Inclination	MSFC	Catholic University, Louvain	Space manufacturing experiment in multipurpose furnace to study pore size and shape of melted and solidified silver grids in weightless environments.
CANADA				
• Long Duration Exposure Facility (LDEF) KSC 1983-1984	Space Shuttle Low Inclination Circular	NASA Langley Research Center (LaRC)	University of Toronto	Determine effects of exposure to the space environment on the mechanical properties of selected polymer matrix composite materials.
DENMARK				
• High Energy Astronomical Observatory-3 (HEAO-3) ETR Sept. 20, 1979	Atlas/Centaur 600 km Circular Low Inclination	MSFC	Danish Space Research Institute (DSRI) (Co- Principal Investigator with National Center for Scientific Research (CNRS), France)	Investigation of isotopic composition and atomic number of galactic incident cosmic nuclei on the periodic table between beryllium and tin.
• LDEF KSC 1983-1985	Space Shuttle Low Inclination Circular	LaRC	Royal Technical University of Denmark/Rockwell Inter- national Science Center	Crystal growth studies under prolonged zero gravity.
o Completed Project				
• Current				

## Experiments on NASA Spacecraft

Country, Name, Launch Site, & Date	Vehicle & Orbit	Spacecraft Responsibility	Principal Experimenter's Affiliation	Experiment Description
EXPERIMENTS WITH FOREIGN PRINCIPAL INVESTIGATORS:				
EUROPEAN SPACE AGENCY (ESA)				
• LDEF KSC 1983-1985	Space Shuttle Low Inclination Circular	LaRC	ESTEC	US/ESA/Ireland tripartite project: ESA investigation of the charge spectrum of cosmic ray nuclei from Z = 30 to uranium and beyond.
FRANCE				
oo Orbiting Geophysical Observatories -2 and -4 (OGO-2, OGO-4) Western Test Range (WTR) Oct. 14, 1965 <u>Jul. 28, 1967</u>	Thrust-augmented Thor-Agena 400-1000 km Low Inclination	NASA Goddard Space Flight Center (GSFC)	Aeronomy Service, CNRS	Measure airglow at 6300 Å, 5577 Å, 3914 Å, and in the near ultraviolet (UV) region with photometer.
o OGO-5 ETR <u>Mar. 4, 1968</u>	Atlas-Agena 280-148,000 km Low Inclination	GSFC	University of Paris	Determine density and temperature of hydrogen in geocorona with hydrogen cell.
o Orbiting Solar Observatory-5 (OSO-5) ETR <u>Jan. 22, 1969</u>	Delta 550 km Circular Low Inclination	GSFC	CNRS	Measure self-reversal of the solar Lyman-Alpha spectrographic line.
o OGO-6 WTR <u>Jun. 5, 1969</u>	Thor-Agena 400-1070 km High Inclination	GSFC	University of Paris	Measure altitude distribution and width of atomic oxygen line in airglow and aurora, and derive temperature and excitation processes in the atmosphere.

## Experiments on NASA Spacecraft

Country, Name, Launch Site, & Date	Vehicle & Orbit	Spacecraft Responsibility	Principal Experimenter's Affiliation	Experiment Description
EXPERIMENTS WITH FOREIGN PRINCIPAL INVESTIGATORS:				
FRANCE (Continued)				
oo Apollo-16, -17 ETR Apr. 16, 1972 <u>Dec. 6, 1972</u>	Saturn V Lunar Trajectory	Manned Spacecraft Center (MSC); now NASA Johnson Space Center (JSC)	Center for Space Studies of Radiation (collaborative with University of Frankfurt- see Germany)	Measurement of effects on selected biosystems of bombardment by heavy nuclei of primary cosmic radiation during manned flight operations. (BIOSTACK experiment)
o Skylab ETR <u>May 14, 1973</u>	Saturn 430 km Circular High Inclination	MSFC	Laboratory for Space Astronomy, CNRS	Provide general sky survey, improve classification of hot young stars up to tenth magnitude, obtain a luminosity distribution of nearby galaxies and investigate distribution of ionized hydrogen.
o OSO-8 ERT <u>Jun. 21, 1975</u>	Delta 550 km Circular Low Inclination	GSFC	University of Paris/ Laboratory of Stellar and Planetary Physics, CNRS	Study the chromosphere fine structure by means of simultaneous high resolution observations of the profile of Lyman-Alpha and Beta, Magnesium II and Calcium H and K lines.
o Apollo-Soyuz Test Project (ASTP) ETR <u>Jul. 15, 1975</u>	Saturn IB 230 km Circular High Inclination	JSC	Paul Sabatier University	Measurement of effects on selected biosystems of bombardment by heavy nuclei of primary cosmic radiation during manned flight operations. (BIOSTACK experiment)
• International Sun-Earth Explorer (ISEE-1 and ISEE-2) NASA/ESA ETR <u>Oct. 22, 1977</u>	Delta 280-138,000 km Low Inclination	GSFC	Paris Observatory	Measure the integrated electron density between ISEE-1 and ISEE-2 spacecraft with very high time resolution using a radio pulsar on ISEE-1 and a receiver on ISEE-2.

## Experiments on NASA Spacecraft

Country, Name, Launch Site, & Date	Vehicle & Orbit	Spacecraft Responsibility	Principal Experimenter's Affiliation	Experiment Description
EXPERIMENTS WITH FOREIGN PRINCIPAL INVESTIGATORS:				
FRANCE (Continued)				
• NASA Heliocentric Mission (ISEE-3) ETR Aug. 12, 1978	Delta Halo Orbit Heliocentric	GSFC	Meudon Observatory	Study three dimensional mapping of the solar wind magnetic field.
o Pioneer Venus-2 ETR Aug. 8, 1978	Atlas/Centaur Planetary Trajectory	NASA Ames Research Center (ARC)	Aeronomy Service, CNRS (Co-Principal Investigator with ARC)	Study the vertical extent, structure, and distribution of the clouds of Venus using a nephelometer.
• TIROS-N WTR Oct. 13, 1978	Atlas F Near Polar Circular	GSFC	National Center for Space Studies, CNES	Demonstrate French Satellite Data Collection System (ARGOS) on TIROS-N for use in polar orbiting meteorological satellites. Provide systems for National Oceanic and Atmospheric Administration ((NOAA), US Department of Commerce) operational satellites in the TIROS-N series.
• HEAO-3 ETR Sept. 20, 1979	Atlas/Centaur 600 km Circular Low Inclination	MSFC	Center for Nuclear Studies, CNRS (Co- Principal Investigator with DSRI)	Investigation of isotopic composition and atomic number of galactic incident cosmic nuclei on the periodic table between beryllium and tin.
• LDEF KSC 1983-1984	Space Shuttle Low Inclination Circular	LaRC	CNRS	Investigation of long term space exposure on thin metal film and evaporated cathodes, optical coatings, holographic gratings, thermal coatings, structural materials, and optical fibers.

## Experiments on NASA Spacecraft

Country, Name, Launch Site, & Date	Vehicle & Orbit	Spacecraft Responsibility	Principal Experimenter's Affiliation	Experiment Description
EXPERIMENTS WITH FOREIGN PRINCIPAL INVESTIGATORS:				
GERMANY				
oo Apollo-16, -17 ETR Apr. 16, 1972 <u>Dec. 6, 1972</u>	Saturn V Lunar Trajectory	JSC	Frankfurt University/ Center for Space Studies of Radiation	Measurement of effects on selected biosystems of bombardment by heavy nuclei of primary cosmic radiation during manned flight operations. (BIOSTACKS I & II)
oo ASTP ETR Jul. 15, 1975	Saturn IB 230 km Circular High Inclination	JSC	Frankfurt University Max Planck Institute (MPI), Martinsried	BIOSTACK III - Measurements similar to BIOSTACKS I & II. Study of electrophoretic separation of blood fractions under zero gravity.
• ISEE-1 and ISEE-2 (NASA/ESA Dual Spacecraft Mission) ETR <u>Oct. 22, 1977</u>	Delta 280-138,000 km Low Inclination	GSFC	MPI, Munich	Investigation of nuclear and ionic charge distribution as a function of energy range (5 KeV-20 MeV).
• NASA Heliocentric Mission (ISEE-3) ETR <u>Aug. 12, 1978</u>	Delta Halo Orbit Heliocentric	GSFC	MPI, Munich	Investigation of nuclear and ionic charge distribution as a function of energy range (5 KeV-20 MeV).
• Pioneer Venus-2 ETR <u>Aug. 8, 1978</u>	Atlas/Centaur Planetary Trajectory	ARC	University of Bonn	Neutral mass spectrometer measurements of the number densities of various atmospheric constituents and their altitude dependence in the upper atmosphere of Venus.

## Experiments on NASA Spacecraft

Country, Name, Launch Site, & Date	Vehicle & Orbit	Spacecraft Responsibility	Principal Experimenter's Affiliation	Experiment Description
EXPERIMENTS WITH FOREIGN PRINCIPAL INVESTIGATORS:				
GERMANY (Continued)				
•• LDEF KSC 1983-1984	Space Shuttle Low Inclination Circular	LaRC	Messerschmitt-Boelkow- Blohm, Munich	Investigation of the combined effect of radiation and contamination on different thermal coatings and on solar cells.
			University of Frankfurt	Investigation of the biological effectiveness of the structured components of cosmic radiation during space flight.
••• International Solar Polar Mission (ISPM) KSC 1985	Space Shuttle Planetary Trajectory Out-of-the-Ecliptic	Jet Propulsion Laboratory (JPL)	Ruhr University, Bochum MPI, Lindau	Zodiacaal light experiment. Mass separating solar wind experiment. Interstellar gas measurement.
•• Project Galileo (formerly Jupiter Orbiter Probe (JOP)) KSC 1985	Space Shuttle Planetary Trajectory	JPL	University of Bonn  MPI, Heidelberg	Precise determination of the helium abundance in the atmosphere of Jupiter at the levels 3-10 bars through use of an optical interferometer for refractive index measurements on atmospheric samples. Determination of the physical and dynamic properties of small dust particles in the environs of Jupiter with emphasis on interaction of dust with the magnetosphere and satellite surfaces.

### INDIA

o Spacelab-3 KSC 1984	Space Shuttle Low Inclination	MSFC	Tata Institute of Funda- mental Research (TIFR)	Studies on the ionization states of solar and galactic cosmic ray heavy nuclei.
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## Experiments on NASA Spacecraft

Country, Name, Launch Site, & Date	Vehicle & Orbit	Spacecraft Responsibility	Principal Experimenter's Affiliation	Experiment Description
EXPERIMENTS WITH FOREIGN PRINCIPAL INVESTIGATORS:				
IRELAND				
<ul style="list-style-type: none"> <li>LDEF KSC 1983-1984</li> </ul>	Space Shuttle Low Inclination Circular	LaRC	Dublin Institute for Advanced Studies	US/Ireland/ESA tripartite project: investigation of the charge spectrum of cosmic ray nuclei from $Z = 30$ to uranium and beyond.
ITALY				
<ul style="list-style-type: none"> <li>OSO-6 ETR Aug. 9, 1969</li> </ul>	Delta 550 km Circular Low Inclination	GSFC	University of Bologna	Solar X-ray monitoring and gamma ray astronomy in the energy range 20-200 KeV.
JAPAN				
<ul style="list-style-type: none"> <li>SkyLab ETR May 14, 1973</li> </ul>	Saturn 430 km Circular High Inclination	MSFC	Japanese National Research Institute for Metals	Space manufacturing experiment to study in multipurpose furnace in weightless environments the production of silicon carbide whisker-reinforced composite metals.
<ul style="list-style-type: none"> <li>Spacelab-1 KSC 1983</li> </ul>	Space Shuttle High Inclination Circular	MSFC	University of Tokyo	Space Experiment with Particle Accelerators (SEPAC)- major space plasma physics facility for active and interactive experiments in the ionosphere and magneto- sphere.

## Experiments on NASA Spacecraft

Country, Name, Launch Site, & Date	Vehicle & Orbit	Spacecraft Responsibility	Principal Experimenter's Affiliation	Experiment Description
EXPERIMENTS WITH FOREIGN PRINCIPAL INVESTIGATORS:				
NETHERLANDS				
o 060-5 ETR March 4, 1968	Atlas-Agena 280-148,000 km Low Inclination	GSFC	Delft Technical Institute	Six-counter telescope to measure absolute flux and energy spectrum of cosmic ray electrons.
• NASA Heliocentric Mission (ISEE-3) ETR Aug. 12, 1978	Delta Halo Orbit Heliocentric	GSFC	Space Research Laboratory (SRL), University of Utrecht	Measurement of energetic electrons and protons at $E > 20$ KeV.
• Solar Maximum Mission (SMM) ETR Feb 14, 1980	Delta Low Inclination Circular	GSFC	SRL, University of Utrecht	US/Netherlands/United Kingdom (UK) tripartite project: hard X-ray imaging spectrometer.
ROMANIA				
• Drop Dynamics Module Spacelab-3 KSC 1984	Space Shuttle Low Earth Orbit High Inclination	MSFC	Babes-Bolyai University	Space processing experiment to investigate the surface flow of liquids in the absence of gravity.

## Experiments on NASA Spacecraft

Country, Name, Launch Site, & Date	Vehicle & Orbit	Spacecraft Responsibility	Principal Experimenter's Affiliation	Experiment Description
EXPERIMENTS WITH FOREIGN PRINCIPAL INVESTIGATORS:				
SWITZERLAND				
000 Apollo-11, -12, 00 -14, -15, -16 ETR	Saturn V Lunar Trajectory	MSC	University of Bern	Experiment to measure composition of solar wind by trapping solar wind ions on sheet of aluminum foil deployed by astronaut and returning foil to Earth for analysis.
Jul. 16, 1969 Nov. 14, 1969 Jan. 31, 1971 Jul. 26, 1972 <u>Apr. 16, 1972</u>				
o Skylab ETR <u>May 14, 1973</u>	Saturn 430 km Circular High Inclination	MSFC	University of Bern	Spectroscopic analysis of solar wind composition.
• LDEF KSC 1983-1984	Space Shuttle Low Inclination Circular	LaRC	University of Bern	Collection and mass spectroscopic analysis of interstellar noble gas atoms.
• ISPM KSC 1985	Space Shuttle Planetary Trajectory Out-of-the-Ecliptic	JPL	University of Bern	Solar wind ion composition spectrometer.

## Experiments on NASA Spacecraft

Country Name, Launch Site, & Date	Vehicle & Orbit	Spacecraft Responsibility	Principal Experimenter's Affiliation	Experiment Description
EXPERIMENTS WITH FOREIGN PRINCIPAL INVESTIGATORS:				
UNITED KINGDOM				
o Explorer-20 WTR <u>Aug. 25, 1964</u>	Scout 870-1020 km Near Polar	GSFC	University College, London	Measure ion mass composition and temperature with ion mass spectrometer. (Similar experiment on Ariel-I.)
oo Explorer-31 (Direct Measurement Explorer) WTR <u>Nov. 29, 1965</u>	Thor-Agena B 500-3000 km High Inclination (Piggyback with Alouette-II)	GSFC	University College, London	Measure ion mass composition and temperature with spherical ion mass spectrometer. (Similar experiment on Ariel-I.)  Measure electron temperature with planar electron temperature probe.
oo OSO-4 ETR <u>Oct. 18, 1967</u>	Delta 550 km Circular Low Inclination	GSFC	University of Leicester/ University College, London	Measure distribution of total solar X-ray emission over a wide band.
			University College, London	Study solar He I and He II resonance emission (304 Å).
oo OGO-5 ETR <u>Mar. 4, 1968</u>	Atlas-Agena 280-138,000 km Low Inclination	GSFC	University College, London	Spherical probe to measure electron density and temperature.
			University of Southampton	Spark chamber to measure direction of incidence of uncharged primary cosmic rays.

## Experiments on NASA Spacecraft

Country, Name, Launch Site, & Date	Vehicle & Orbit	Spacecraft Responsibility	Principal Experimenter's Affiliation	Experiment Description
EXPERIMENTS WITH FOREIGN PRINCIPAL INVESTIGATORS:				
UNITED KINGDOM (Continued)				
o OSO-5 ETR <u>Jan. 22, 1969</u>	Delta 550 km Circular Low Inclination	GSFC	University of Leicester/ University College, London	Measure solar X-ray flux with spectroheliograph.
o OSO-6 ETR <u>Aug. 9, 1969</u>	Delta 550 km Circular Low Inclination	GSFC	University College, London	Study of Solar He I and He II resonance radiation by means of a twin-line monochromator.
o Nimbus-4 ETR <u>Apr. 8, 1970</u>	Thor-Agena 1100 km Circular High Inclination	GSFC	Reading University/Oxford University	Selective chopper radiometric temperature probe.
o Orbiting Astronomical Observatory-3 (OAO-3) ETR <u>Aug. 21, 1972</u>	Atlas-Centaur 740 km Circular Mid Inclination	GSFC	University College, London/University of Leicester	Study the X-ray emission of stars and nebulae and obtain information on the interstellar absorption of He and the heavier elements.
o Nimbus-5 ETR <u>Dec. 11, 1972</u>	Delta 1100 km Circular High Inclination	GSFC	Heriot Watt University Oxford University	Selective chopper radiometer for water vapor, cloud, and atmospheric temperature sounding.
o Nimbus-6 WTR <u>Jun. 12, 1975</u>	Delta 1100 km Circular High Inclination	GSFC	Oxford University	Pressure modulated carbon dioxide radiometer for upper atmosphere temperature sounding.

## Experiments on NASA Spacecraft

Country, Name, Launch Site, & Date	Vehicle & Orbit	Spacecraft Responsibility	Principal Experimenter's Affiliation	Experiment Description
EXPERIMENTS WITH FOREIGN PRINCIPAL INVESTIGATORS:				
UNITED KINGDOM (Continued)				
● TIROS-N WTR Oct. 13, 1978	Atlas F 830 km Circular Near Polar	GSFC	Meteorological Office, UK Air Ministry	Provide a stratospheric sounding radiometer system to demonstrate this technology for use in future operational meteorological satellite systems. Provide future systems to NOAA for future operational satellites in the TIROS-N series.
● Nimbus-7 WTR Oct. 24, 1978	Delta 955 km Circular Near Polar	GSFC	Oxford University	Radiometer for stratospheric and mesospheric sounding.
● SMM ETR Feb. 14, 1980	Delta Circular Low Inclination	GSFC	University of Birmingham	US/UK/Netherlands tripartite project: hard imaging X-ray spectrometer.
●● LDEF KSC 1983-1984	Space Shuttle Circular Low Inclination	LaRC	University of Reading  Kent University	Investigation of effects of exposure to the space environment of high performance infrared multilayer filters.  Investigation of erosion effects by exposure of multiple foil arrays.
●● Space lab-2 KSC 1983	Space Shuttle High Inclination	MSFC	University of Birmingham  Appleton Laboratory and University College, London	Hard X-ray imaging of clusters of galaxies and other extended X-ray sources.  Determination with high accuracy of the absolute abundance of helium in the solar corona.

## Experiments on NASA Spacecraft

Country Name, Launch Site, & Date	Vehicle & Orbit	Spacecraft Responsibility	Principal Experimenter's Affiliation	Experiment Description
US EXPERIMENTS WITH FOREIGN CO-INVESTIGATORS OR TEAM MEMBERS:				
oo Pioneers 6-9 oo Dec. 16, 1965 Aug. 17, 1966 Dec. 13, 1967 Nov. 8, 1968	India	Physical Research Laboratory (PRL), Ahmedabad		GSFC: Cosmic ray anisotropy.
o Gemini-9 Jun. 3, 1966	Israel	Tel Aviv University		Dudley Observatory: Micrometeorite collection.
o Gemini-10 Jul. 18, 1966	Germany	MPI, Heidelberg		Dudley Observatory: Micrometeorite collection.
oo Gemini-12 Nov. 11, 1966	United Kingdom	Birkbeck College University of London		Dudley Observatory: Micrometeorite collection.
o Pioneer-8 Dec. 13, 1967	Israel	Tel Aviv University		Dudley Observatory: UV imaging of dust in upper atmosphere.
o OGO-6 Jun. 5, 1969	Italy	University of Rome University of Aquila		GSFC: Flux gate magnetometer.
o Apollo-11 Jul. 16, 1969	France	University of Paris		University of Pittsburgh: Sodium airglow.
o Apollo-12 Nov. 14, 1969	Australia	University of Sydney		MSC: Data analysis of lunar dust.
	Australia	University of Sydney		MSC: Detector experiments on early Apollo Surface Experiments Package (EASEP) on Apollo-11 and Apollo Lunar Surface Experiments Package (ALSEP) on Apollo-12.

## Experiments on NASA Spacecraft

Project and Date	Country	Co-Experimenter's/ Team Member's Affiliation	Experiment
US EXPERIMENTS WITH FOREIGN CO-INVESTIGATORS OR TEAM MEMBERS:			
o Apollo-16 <u>Apr. 16, 1972</u>	Germany	University of Frankfurt	JSC: Microbial ecology evaluation device.
o Meteoroid Technology Satellite <u>Aug. 13, 1972</u>	Germany	MPI, Heidelberg	ARC: Cosmic dust detectors.
o Pioneer-10, -11 Mar. 3, 1972 <u>Apr. 16, 1973</u>	Germany Australia	MPI, Munich University of Adelaide	ARC: Plasma detector. GSFC: Cosmic rays.
oo Interplanetary Monitoring Platform (IMP) IMP-H <u>Sep. 22, 1972</u> <u>IMP-J</u> <u>Oct. 25, 1973</u>	Germany	MPI, Munich	University of Maryland: Very low energy cosmic ray composition.
o Skylab <u>May 14, 1973</u>	Switzerland	University of Bern	JSC: Magnetospheric particle composition.
o Mariner-10 <u>Nov. 3, 1973</u>	France United Kingdom	Paris Observatory University of London	JPL: Television science team. JPL: Television science team.
ooo Atmospheric Explorer-C, -D & -E <u>Dec. 16, 1973</u> <u>Oct. 6, 1975</u> <u>Nov. 19, 1975</u>	United Kingdom	York University	University of Michigan: Airglow photometer.

## Experiments on NASA Spacecraft

Project and Date	Country	Co-Experimenter's/ Team Member's Affiliation	Experiment
US EXPERIMENTS WITH FOREIGN CO-INVESTIGATORS OR TEAM MEMBERS:			
oo Helios Dec. 10, 1974 Jan. 15, 1976	Australia Italy	University of Adelaide University of Rome	GSFC: Cosmic rays. GSFC: Flux gate magnetometer.
o OSO-8 Jun. 21, 1975	United Kingdom	University College, London	Lockheed Palo Alto Research Laboratory (LPARL): Mapping X-ray heliumeter.
oo ASTP Jul. 15, 1975	Germany	University of Mainz University of Frankfurt	JSC: Killifish hatching and orientation. Lawrence Radiation Laboratory: Light flash and charged particle correlations.
oo Viking-1 and -2 Aug. 20, 1975 Sep. 9, 1975	United Kingdom	Nuffield Radio Astronomical Laboratories, Jodrell Bank	LaRC: Radio Science Team.
••• Voyager-1 and Voyager-2 (For- merly Mariner Jupiter/Saturn) Aug. 20, 1977 Sep. 5, 1977	Germany France United Kingdom	Technical University of Braunschweig University of Paris Meteorological Office, UK Air Ministry	GSFC: Magnetometer. University of Colorado: Planetary radio astronomy team. New Mexico State University: Imaging science team.
••• ISEE-1 (NASA/ESA Dual Spacecraft Mission) Oct. 22, 1977	France Sweden Germany Switzerland	Paul Sabatier University Royal Institute of Technology MPI, Munich University of Bern	University of California at Berkeley: Energetic particles. University of California at Berkeley: Quasi-static electric field. LPARL: Plasma composition. LPARL: Plasma composition.
••• Pioneer Venus-1 (Orbiter) May 20, 1978	United Kingdom Germany ESA	Oxford University Institute for Space Physics- Freiburg ESTEC	JPL: Radiometric temperature sounding. LPARL: Retarding potential analyzer. GSFC: Langmuir Probe

## Experiments on NASA Spacecraft

Project and Date	Country	Co-Experimenter's/ Team Member's Affiliation	Experiment
US EXPERIMENTS WITH FOREIGN CO-INVESTIGATORS OR TEAM MEMBERS:			
● Pioneer Venus-2 (Multiprobe) <u>Aug. 8, 1978</u>	France	University of Lille	University of Wisconsin: Solar flux and atmospheric absorption.
● ISEE-3 <u>Aug. 12, 1978</u>	Switzerland	University of Bern	GSFC: Solar wind composition.
●● Nimbus-7 <u>Oct. 24, 1978</u>	United Kingdom Germany	National Physical Laboratory, British Aerospace University of Munich	LaRC: Limb Infrared (IR) Monitor of the Stratosphere (LIMS). GSFC: Scanning multichannel microwave radiometer. LaRC: LIMS
●● SMM ETR <u>Feb. 14, 1980</u>	United Kingdom Germany	University College, London MPI, Munich	LPARL: X-ray polychromator for solar flare studies. University of New Hampshire: Solar gamma ray observations.
● Space lab-1 <u>1983</u>	Canada	Defense and Civil Institute of Environmental Medicine and McGill University Laboratory for Space Astronomy (LAS) CNRS	Massachusetts Institute of Technology (MIT): Vestibular experiments in Spacelab.
●● Space Telescope <u>1984</u>	France Canada United Kingdom	Dominion Astrophysical Observatory Cambridge University	University of California at Berkeley: Far UV observations using the FAUST (Far UV Space Telescope) instrument on the Spacelab-1 mission. GSFC: High resolution spectrometer. Interdisciplinary scientists.

## Experiments on NASA Spacecraft

Project and Date	Country	Co-Experimenter's/ Team Member's Affiliation	Experiment
US EXPERIMENTS WITH FOREIGN CO-INVESTIGATORS OR TEAM MEMBERS:			
●●● ISPM ●● 1985	France Germany France	Paris Observatory MPI, Garching Paris Observatory Center for Research on the Physics of the Environment Laboratory for External Geophysics	High Altitude Observatory: X-ray and white-light coronagraph. Caltech: Comprehensive particle analysis system. GSFC: Unified radio and plasma wave experiment.
	Germany	Technical University of Braunschweig MPI, Lindau	GSFC: Magnetic field experiment.
	Italy	University of Bonn National Research Council (CNR)	GSFC: Magnetic field experiment.
● LDEF KSC 1983-1984	ESA	ESTEC	NASA Lewis Research Center (LeRC): Advanced Photovoltaic Experiment.
●●● Project Galileo ●●● 1984	Germany  France  Canada	Technical University of Braunschweig MPI, Lindau MPI, Garching University of Munich CNES CNES Meudon Observatory University of Calgary	Bell Labs/University of Florida: Lightning and 1 Hz to 100 KHz radio waves. University of Iowa: Jovian plasma investigation. NOAA: Jovian orbital magnetospheric particles instrument. JPL: Imaging team. ARC: Cloud nephelometer. University of Iowa: Jovian plasma investigation. JPL: Near IR mapping spectrometer. JPL: Imaging team.

## US Experiments on Foreign Spacecraft

Country, Name, Launch Site, and Date	Vehicle & Orbit	Spacecraft Responsibility	Experimenter's Affiliation	Experiment Description
EUROPEAN SPACE AGENCY (ESA)				
oo OTS and OTS back-up ETR Sep. 13, 1977* <u>May 11, 1978</u>	Delta 360 km Geosynchronous	ESA	NASA Lewis Research Center (LeRC)	Transient events counter to study spacecraft electro- static charging.
GERMANY				
o Aeros-B WTR <u>Jul. 16, 1974</u>	Scout 221-800 km High Inclination	Federal Ministry for Research and Technology (BFMT)	NASA Goddard Space Flight Center (GSFC)	Neutral Atmosphere Temperature Experiment.
o Firewheel Kourou, French Guiana <u>May 23, 1980*</u>	Ariane (sub-orbital)	BFMT	GSFC	Five DC magnetometers (on bus and 4 subpayloads) and one subpayload instrumented for plasma physics experi- ments.
JAPAN				
o Electron Accele- rator/Tether Experiment <u>Jan 16, 1980</u>	K-9M-69 Sounding Rocket (sub-orbital)	ISAS	Utah State Univ.	Investigation of current collection processes in ionosphere plasma at high potential, using a rocket-borne electron accelerator and long conducting tether.
o Reflight of Experiment 1981	K-9M-69 Sounding Rocket	ISAS	Utah State Univ.	Investigation of current collection processes in ionosphere plasma at high potential, using a rocket-borne electron accelerator and long conducting tether.

\*Desired orbit not achieved.

## Cooperative Sounding Rocket Projects

Country and Cooperating Agency	Number, Type of Rocket, and Altitude	Launch Site and Date	Experimenter and Project Description
ARGENTINA			
National Commission for Space Research (CNIE)	2 Nike-Cajun above 90 km	Chamical, Argentina Dec. 1964	National University of Tucuman: Measure D and E region electron density and temperature, ion density and ultraviolet (UV) radiation.
	12 Arcas 60 km	Tartagal, Argentina Nov. 1966	Atmospheric Sciences Laboratory/CNIE: Observe changes in wind, temperature, and ozone in the upper atmosphere associated with the total solar eclipse of November 12, 1966.
	3 Orion 85 km	Wallops Island Nov. 1966	CNIE: Obtain data on vehicle flight performance characteristics for Argentine-built sounding rockets.
	2 Nike-Apache 90-140 km	Chamical Sep. 1967	National University of Tucuman: Investigate physical processes producing sporadic E.
	38 Boosted Dart and Arcas	Chamical Apr. 1966-Apr. 1968	CNIE: Project constitute one element of Experimental Inter-American Meteorological Sounding Rocket Network (EXAMETNET).
	48 Boosted Dart and Arcas	Mar Chiquita, Argentina May 1968-Dec. 31, 1971	In May 1968, CNIE moved EXAMETNET which was conducted from 1966-1980. In May 1968, CNIE moved EXAMETNET operations from Chamical to the Argentine Atlantic range near Mar Chiquita.
	17 Boosted Dart	1972	
	24 Boosted Dart	1973	
	10 Boosted Dart	1974	
	9 Boosted Dart	1975	
	27 Boosted Dart	1976	
	50 Boosted Dart	1977	
	28 Boosted Dart	1978	
	16 Boosted Dart up to 65 km	1979	
	20 Super Loki Optical Ozoneonde up to 70 km	Mar Chiquita, Argentina Marambio, Antarctica 1981	CNIE: Obtain correlative data on atmospheric constituents and their distributions and on temperature and wind conditions.
	20 Super Loki Datasonde		

## Cooperative Sounding Rocket Projects

Country and Cooperating Agency	Number, Type of Rocket, and Altitude	Launch Site and Date	Experimenter and Project Description
AUSTRALIA			
Department of Supply	4 Skylark 200 km	Woomera, Australia Sep.-Nov. 1961	NASA Goddard Space Flight Center (GSFC): Measure stellar and nebular UV radiation in southern skies. Compare with northern hemisphere data.
Commonwealth Scientific and Industrial Research Organization (CSIRO)	2 Aerobee 150 A 2 Aerobee 150 A above 120 km	Wallops Island Nov.-Dec. 1962 Apr.-May 1963	CSIRO: Measure very low frequency (VLF) radio noise in the ionosphere.
Department of Supply	3 Aerobee 150 205 km	Woomera May-Jun. 1970	Manned Spacecraft Center (MSC), now NASA Johnson Space Center (JSC)/University of Wisconsin/University of Adelaide/University of Tasmania: Measure X-ray and UV radiation from selected stars in southern skies.
Department of Supply	7 Aerobee 170 175 km	Woomera Nov. 1973	Massachusetts Institute of Technology (MIT)/CalTech/University of Wisconsin/Naval Research Laboratory: X-ray studies of sources unique to the southern skies.
University of Adelaide/Australian Department of Defense (ADOD)	7 Aerobee 175 km	Woomera Feb. 1977	University of Adelaide/Johns Hopkins University/Columbia University/Naval Research Laboratory: X-ray and UV studies of sources unique to the southern skies.
BRAZIL			
National Commission for Space Research (CNAE)	1 Nike-Apache 80 km 2 Nike-Apache 80 km	Wallops Island Aug. 1965 Natal, Brazil Dec. 1965	CNAE/GSFC: Evaluate cosmic ray effects on the lower D region of the ionosphere.

## Cooperative Sounding Rocket Projects

Country and Cooperating Agency	Number, Type of Rocket, and Altitude	Launch Site and Date	Experimenter and Project Description
BRAZIL (Continued)			
CNAE (Continued)	64 Boosted Dart and Arcas 12 Boosted Dart	Natal <u>Jan. 1, 1966-Dec. 31, 1971</u> <u>1972</u>	CNAE: Project constitutes one element of EXAMETNET, an experimental research network to obtain high altitude meteorological data.
	9 Nike-Cajun 13 Nike-Cajun 3 Nike-Cajun 40-100 km	Natal May-Dec. 1966 <u>Jun.-Dec. 1967</u> <u>Mar. 1968</u>	CNAE/GSFC: Measure wind, temperature, pressure, and density using grenade technique.
	1 Black Brant IV 2 Black Brant IV approx. 800 km	Natal <u>Jun. 1968</u> <u>Sep. 1970</u>	GSFC/MSFC: Measure dynamics of inner radiation belts in South Atlantic Anomaly region.
	1 Black Brant IV 1 Black Brant IV approx. 800 km	Natal <u>Jun. 1969</u> <u>Sep. 1969</u>	Cambridge Research Laboratory/MSFC: Investigate reflection, absorption, and transmission of radio waves in the ionosphere, near the Geomagnetic Equator.
	1 Nike-Apache 1 Nike-Tomahawk 17 Nike-Hydac 1 Nike-Javelin 180-700 km	Cassino, Brazil <u>Nov. 1966</u>	CNAE/GSFC: Various United States (US) and Brazilian experimenters: Study the effects of the solar eclipse of November 12, 1966 on the Earth's atmosphere. Investigate solar X-ray source functions.
	1 Aerobee 150 205 km	Natal <u>Dec. 1966</u>	Catholic University: Identify new X-ray sources in the Southern Hemisphere.
	1 Nike-Tomahawk approx. 350 km	Natal <u>Mar. 1967</u>	University of New Hampshire: Measure intensity of cosmic particles, flux, Lyman-Alpha radiation, and ionospheric electron density.

## Cooperative Sounding Rocket Projects

Country and Cooperating Agency	Number, Type of Rocket, and Altitude	Launch Site and Date	Experimenter and Project Description
BRAZIL (Continued)			
CNAE (Continued)	2 Javelin approx. 1000 km	Natal <u>Jun. 1967</u>	US/Brazil/Germany tripartite agreement: MPI, Lindau/University of Kiel/MPI, Munich/Technical University of Braunschweig. Flight test instrumentation for the German research satellite AZUR and investigate proton and electron energy spectra, proton flux, and solar and galactic alpha particles.
	1 Aerobee 150 205 km	Natal <u>Nov. 1967</u>	Cambridge Research Laboratory: Measure day airglow emissions in equatorial regions.
	2 Nike-Iroquois 70-160 km	Natal <u>Nov. 1967</u>	Cambridge Research Laboratory: Engineering tests of payloads to measure meteoroid flux in upper atmosphere.
	4 Nike-Iroquois 70-160 km	Natal <u>Aug. 1968</u>	Cambridge Research Laboratory: Measure meteoroid flux in the upper atmosphere with recoverable payloads.
	2 Aerobee 150 205 km	Natal <u>Jun. 1969</u>	CNAE: Examine celestial X-ray emission sources in Southern Hemisphere.
	1 Javelin approx. 1000 km	Natal <u>Jun. 1969</u>	Southwest Center for Advanced Studies: Determine the ion composition of the F region of the ionosphere.
	1 Aerobee 150 205 km	Natal <u>Mar. 1969</u>	Cambridge Research Laboratory: Determine infrared (IR) profile of Earth's horizon in equatorial region.
	1 Black Brant IV approx. 800 km	Natal <u>Sep. 1969</u>	MSC/Lawrence Radiation Laboratory: Determine measurements of the charged particle environment in the South Atlantic Anomaly region.
	4 Black Brant V-C	Natal <u>Jan.-Feb. 1973</u>	CNAE: Atmospheric soundings in support of AEROS Satellite.

## Cooperative Sounding Rocket Projects

Country and Cooperating Agency	Number, Type of Rocket, and Altitude	Launch Site and Date	Experimenter and Project Description
BRAZIL (Continued)			
Institute of Space Research (INPE), Formerly CNAE	14 Boosted Dart 22 Boosted Dart 6 Boosted Dart 19 Boosted Dart 34 Boosted Dart 11 Boosted Dart 7 Boosted Dart 11 Boosted Dart up to 65 km	Natal 1973 <u>1974</u> <u>1976</u> <u>1977</u> <u>1978</u> <u>1979</u> <u>Marambaia, Brazil</u> <u>1976</u>	INPE: Continuation of EXAMETNET.
National Council on Scientific and Technological Development (CNPq)	2 Javelin approx. 1000 km	Natal <u>Nov. 1973</u>	US/Brazil/Germany tripartite agreement: MPI, Munich/University of California at Berkeley/INPE. To continue barium cloud studies studies under spread-F conditions.
Commission for Space Activities (COBAE)	4 ozonesondes 6 ozonesondes* ozonesondes*	Natal <u>Nov. 1978-1980</u> <u>1978</u> <u>1979</u> <u>1980</u>	Nimbus-7 and Stratospheric Aerosol and Gas Experiment (SAGE) atmospheric research calibration and verification of satellite sensor measurements.
CANADA			
National Research Council of Canada (NRCC)	6 Black Brant III 100 km	Wallops Island <u>Jun./Dec. 1962</u>	NRCC: Determine vehicle flight performance characteristics and obtain engineering data on effectiveness of instrumentation. Cosmic ray sensor and magnetometer included. (Churchill Research Range Facilities inoperative during this period due to fire damage.)

\* As of December 1980

## Cooperative Sounding Rocket Projects

Country and Cooperating Agency	Number, Type of Rocket, and Altitude	Launch Site and Date	Experimenter and Project Description
CANADA (Continued)			
NRCC (Continued)	176 NASA-Sponsored Launchings	Churchill Research Range, Canada <u>Jan. 1966-Dec. 1976</u>	NRCC/GSFC: Various Canadian and US experimenters use the range for launching sounding rockets in auroral zone to study atmospheric and ionospheric phenomena.
	2 Boosted Arcas	Resolute Bay, Canada <u>Oct. 1967</u>	NRCC/GSFC: Study polar cap absorption events and D region ionosphere and measure height profile of high energy protons.
	2 Boosted Arcas	<u>Aug. 1968</u>	
	1 Boosted Arcas	<u>Oct. 1969</u>	
	100 km		
	1 Black Brant IV approx. 800 km	Wallops Island <u>May 1968</u>	Defense Research Telecommunications Establishment (DRTE): Flight test instrument designed for International Satellite for Ionospheric Studies (ISIS-A) to investigate VLF noise in one to ten kilocycle range.
	3 Nike-Tomahawk approx. 350 km	Cape Parry, Northwest Territory <u>Mar. 1969</u>	GSFC: Study ionospheric currents, upper atmosphere wind variations, and electric fields by the barium release technique.
	1 Black Brant V-C approx. 300 km	Churchill Research Range <u>Feb. 1978</u>	NRCC/National Oceanic and Atmospheric Administration (NOAA)/Max Planck Institute (MPI), Lindau: Investigation to explore electric fields directed parallel to the geomagnetic field at high latitudes.
	1 Astrobe D approx. 80 km	Churchill Research Range <u>Feb. 1979</u>	University of Michigan: Measurements of nitric oxide.
	1 Black Brant X	Wallops Island Spring 1981	NRC/GSFC: Flight test of three-stage Black Brant vehicle.

## Cooperative Sounding Rocket Projects

Country and Cooperating Agency	Number, Type of Rocket, and Altitude	Launch Site and Date	Experimenter and Project Description
CANADA (Continued)			
NRCC (Continued)	NASA-Sponsored Launchings: 2 Taurus Orion approx. 175 km 3 Nike Tomahawk approx. 130 km 3 Astrobee D approx. 80 km	Chikuni, Canada <u>Feb. 1979</u>	Solar eclipse observations made by Canadian and US exper- imenters at special sites established by NRCC. NASA-spon- sored investigators including University of Pittsburgh, University of Illinois, Pennsylvania State University and Cornell University conducted aeronomy and plasma physics studies.
DENMARK			
Danish Research Administration (DRA)	2 Nike-Tomahawk approx. 250 km	Sondre Stromfjord, Greenland <u>Jul. 1974</u>	Danish Meteorological Institute/University of Texas: Electric and magnetic fields and energetic particle measurements in the polar cusp region of the ionosphere.
Danish Space Research Institute (DSRI)	2 Nike-Tomahawk approx. 250 km	Sondre Stromfjord <u>Aug. 1976</u>	DSRI/University of California at Berkeley: Continue investiga- tions of the polar cusp region of the ionosphere with electric field, low-energy particle electron density and temperature and magnetic field measurements.
DRA	2 Nike-Tomahawk approx. 250 km	Fairbanks, Alaska <u>Feb. 1978</u>	Danish Meteorological Institute/Cornell University: Study of coupling between ionized and neutral components of the thermos- phere using chemical release techniques.

## Cooperative Sounding Rocket Projects

Country and Cooperating Agency	Number, Type of Rocket, and Altitude	Launch Site and Date	Experimenter and Project Description
EUROPEAN SPACE AGENCY (ESA)	1 Aerobee 200 approx. 300 km	White Sands, New Mexico <u>Oct. 1974</u>	European Space Technology Center (ESTEC)/GSFC: Demonstrate and study start-up behavior and thermal performance of various heat pipe designs under zero gravity.
FRANCE			
National Center for Space Studies (CNES)	2 Aerobee 150 2 Aerobee 150 above 280 km	Wallops Island <u>Oct. 1963</u> <u>Sep. 1965</u>	National Center for Telecommunications Studies (CNET): Study irregularities in the ionosphere through simultaneous measurements of VLF field strength and local electron density.
	2 French Dragon approx. 400 km 2 French Centaure approx. 190 km	Hammaguir, Algeria <u>Apr. 1964</u>	CNES/GSFC: Simultaneously measure charged particle and neutral gas temperatures in the ionosphere.
	1 Aerobee 150 1 Aerobee 150 1 Aerobee 150 approx. 280 km	White Sands, New Mexico <u>Nov. 1964</u> <u>Nov. 1965</u> <u>Jun. 1967</u>	National Center for Scientific Research (CNRS): One of several experimenters providing special sampling surfaces to collect and analyze extraterrestrial dust particles as part of Project Luster.

## Cooperative Sounding Rocket Projects

Country and Cooperating Agency	Number, Type of Rocket, and Altitude	Launch Site and Date	Experimenter and Project Description
FRANCE (Continued)			
CNES (Continued)	4 Nike-Cajun 12 Nike-Cajun approx. 75 km 3 French Centaure approx. 120 km	Kourou, French Guiana Mar. 1971 <u>Sep. 1971</u> <u>Sep. 1971</u>	CNES/GSFC: Measurement of thermodynamic structure and circulation of equatorial atmosphere between 30 and 95 km and the flow of atmospheric tides.
	3 Arcas approx. 60 km	Kerguelen Islands <u>Feb. 1972</u>	CNES/University of Houston: Measurement of X-ray flux due to precipitating electrons during periods of intense VLF chorus activity.
National Meteorology Agency (MN)	8 Super-Arcas 10 Loki-Dart approx. 60 km	Wallops Island <u>Mar. 1972</u>	MN/Wallops Station: World Meteorological Organization (WMO) sponsored sounding rocket intercomparison tests among France, Japan, and NASA to improve the correlation of data returned by independent future launchings of various rocket systems.
CNES	1 Nike-Apache 1 Indian Centaure approx. 120-150 km	Thumba, India <u>Oct. 1972</u> <u>Sep. 1973</u>	CNES/GSFC/Department of Space (DOS): Describe steady-state electrojet and study plasma instabilities by means of simultaneous launchings of magnetometers, Langmuir and resonance probes, and electric fields payloads.
	14 Super-Arcas approx. 150 km 21 Super-Loki approx. 75 km	Kourou <u>Sep. 1973</u>	MN/Wallops Station: WMO sponsored sounding rocket intercomparison tests among France, United Kingdom (UK), Union of Soviet Socialist Republics (USSR), and NASA to improve the correlation of data returned by independent future launchings of various rocket systems.
	1 Black Brant V-C approx. 800 km 1 Black Brant V-C approx. 800 km	White Sands <u>Feb. 1974</u> <u>Jan. 1975</u>	Laboratory of Stellar and Planetary Physics (LPSP), CNRS/University of Colorado: High resolution spectroscopy of the solar helium line in connection with Pioneer 10 program.

## Cooperative Sounding Rocket Projects

Country and Cooperating Agency	Number, Type of Rocket, and Altitude	Launch Site and Date	Experimenter and Project Description
FRANCE (Continued)			
CNES (Continued)	1 Veronique approx. 212 km	Kourou <u>Apr. 1975</u>	Laboratory of Space Astronomy/University of California at Berkeley: Study of the UV spectrum of Quasar 3C 273 as part of the CNES Rocket Astronomy Program "FAUST." Rocket data to be used to derive the density of the intergalactic medium.
	13 Super-Arcas approx. 150 km	Kourou 1973	CNES participation in EXAMETNET.
	18 Super-Arcas	1974	
	12 Super-Arcas	1975	
	15 Super-Arcas	1976	
	15 Super-Arcas	1977	
	22 Super-Arcas	1978	
	14 Super-Arcas approx. 150 km	1979	
	1 Black Brant	White Sands	LPS/CNRS/University of Colorado: Project "Kalos" to calibrate instruments developed for flight in Orbiting Solar Observatory- (OSO-8) spacecraft.
	1 Black Brant approx. 800 km	<u>Aug. 1975</u> <u>Feb. 1976</u>	
	1 Astrobee F approx. 250 km	White Sands, New Mexico <u>Mar. 22, 1980</u>	Smithsonian Astrophysical Observatory (SAO)/Centre d'Etudes Nucleaires de Saclay (CENS): Study diffuse, soft x-ray background in energy range 0.4 to 2 keV using a Si(Li) Detector.

## Cooperative Sounding Rocket Projects

Country and Cooperating Agency	Number, Type of Rocket, and Altitude	Launch Site and Date	Experimenter and Project Description
GERMANY			
Federal Ministry for Education and Science (BMBW)	1 Aerobee 150	White Sands, New Mexico Nov. 1964	MPI, Heidelberg: One of several experimenters providing special sampling surfaces to collect and analyze extra-terrestrial dust particles as part of Project Luster.
	1 Aerobee 150	Nov. 1965	
	1 Aerobee 150	Oct. 1966	
	2 Aerobee 150 approx. 280 km	Jun/Aug. 1967	
BMBF	1 Nike-Apache approx. 195 km	Wallops Island Jul. 1966	Ionospheric Institute of Breisach: Variable frequency impedance probe to measure electron density.  MPI, Munich: Observations of artificial ion clouds to investigate the physics of comets, the interplanetary medium, and the Earth's magnetosphere.
	1 Javelin approx. 950 km	Wallops Island Sep. 1966	
	1 Nike-Tomahawk approx. 300 km	Wallops Island Sep. 1966	
	1 Nike-Apache approx. 250 km	Churchill Research Range, Canada Nov. 1966	
BMBW	5 Nike-Apache	Kiruna, Sweden Apr./Dec. 1967	MPI, Munich: To investigate electric fields in the upper atmosphere, particularly during an auroral event by observations of ionized clouds.  US/Germany/Brazil tripartite agreement: MPI, Lindau/University of Kiel/MPI, Munich/Technical University of Braunschweig. Flight test instrumentation for the German research satellite AZUR and investigate proton and electron energy spectra, proton flux, and solar and galactic alpha particles.
	2 Nike-Apache approx. 250 km	Jun. 1968	
	2 Javelin approx. 1000 km	Natal, Brazil Jun. 1967	

## Cooperative Sounding Rocket Projects

Country and Cooperating Agency	Number, Type of Rocket, and Altitude	Launch Site and Date	Experimenter and Project Description
GERMANY (Continued)			
BMBW (Continued)	4 Nike-Apache approx. 250 km	Thumba, India <u>Mar. 1968</u>	US/Germany/India tripartite agreement: Physical Research Laboratory (PRL), Ahmedabad/MPI, Munich: Investigate electric fields in the equatorial electrojet by means of artificial barium-ion clouds.
	2 Nike-Apache approx. 250 km	Kiruna <u>Jun. 1968</u>	MPI, Heidelberg: Register micrometeorites and cosmic dust.
	1 Javelin approx. 1000 km	Wallops Island <u>Oct. 1970</u>	MPI, Munich: Continue barium cloud studies and test prototype for Scout-launched barium payload.
	1 Aerobee 170	White Sands <u>Apr. 1971</u>	Working Group for Space Physics, Freiburg: Measure solar coronal extreme ultraviolet (EUV) radiation. The 1973 flights were in support of operations of the Apollo telescope mount on Skylab.
	1 Aerobee 150	<u>Apr. 1972</u>	
	1 Aerobee 200	<u>Aug. 1973</u>	
	1 Aerobee 200 approx. 210 km	<u>Dec. 1973</u>	
	4 Black Brant V-C 285-350 km	Natal <u>Jan.-Feb. 1973</u>	MPI, Heidelberg/University of Bonn/Working Group for Space Physics, Freiburg/MPI, Lindau/ DFVLR Extraterrestrial Sensor Technology Group: Conduct aeronomic investigations timed with the overflight of the AEROS Satellite to achieve intercalibration and completion of vertical profile measurements at subsatellite altitudes.
	1 Black Brant V-C approx. 160 km	Wallops Island <u>Jun. 1974</u>	University of Bonn: Measurement of (1) atomic oxygen densities in the lower thermosphere; (2) altitude profiles of minor constituents such as argon, carbon dioxide, ozone, etc.; and (3) the fine structure of the turbopause. Conducted as part of the ALADDIN Campaign to obtain a complete description of the neutral and ionized atmosphere in a 24-hr. period.

## Cooperative Sounding Rocket Projects

Country and Cooperating Agency	Number, Type of Rocket, and Altitude	Launch Site and Date	Experimenter and Project Description
GERMANY (Continued)			
BMFT (Continued)	2 Javelin approx. 1000 km	Nata1 <u>Nov. 1973</u>	US/Germany/Brazil tripartite agreement: MPI, Munich/University of California at Berkeley/INPE. To continue barium cloud studies under spread-F conditions.
	1 Aerobee 200 approx. 300 km	White Sands <u>Oct. 1974</u>	German Space Research Corporation (GSF)/GSFC: Demonstrate and study start-up behavior and thermal performance of various heat pipe designs under zero gravity.
	2 Black Brant V approx. 300 km	White Sands <u>Jan. 1976</u>	NASA Marshall Space Flight Center (MSFC)/University of Hamburg/University of Clausthal: Metallurgical experiments in zero gravity as part of the NASA space processing basic research program.
	1 Aries	Kiruna	MPI, Munich/University of California at Berkeley: Project Porcupine sounding rocket program to support the International Magnetospheric Study by a complex of in situ particles and field measurements, barium cloud releases, and ground observations under auroral activity conditions. Project Porcupine included experimenters from ESA, Germany, France, and Austria.
	1 Aries	<u>Mar. 1976</u>	
	2 Aries approx. 500 km	<u>Mar. 1979</u>	
	1 Black Brant V-C approx. 300 km	Churchill Research Range <u>Feb. 1978</u>	NRCC/NOAA/MPI, Lindau: Investigation to explore electric fields directed parallel to the geomagnetic field at high latitudes.
	2 Nike-Black Brant approx. 500 km	White Sands <u>Sep. 1978</u> <u>Jul. 1979</u>	Lockheed Palo Alto Research Laboratory (LPARL)/Institute for Space Physics Research (IPW), Freiburg: Acquisition of solar corona spherical data at X-ray and EUV wavelength and full solar disc imagery in the line of C 111.

## Cooperative Sounding Rocket Projects

Country and Cooperating Agency	Number, Type of Rocket, and Altitude	Launch Site and Date	Experimenter and Project Description
Germany (Continued)			
BMFT (Continued)	3 Taurus-Orion 150 km	Kiruna Oct. 1980-Jan. 1981	University of Wuppertal/GSFC/NASA Wallops Flight Center (WFC)/Air Force Geophysics Laboratory/DFVLR/Norwegian Council for Scientific and Industrial Research (CSIRO)/Science Research Council, UK/ESA: To study energetic processes in the upper atmosphere at northern latitudes.
	4 Nike-Orion 180 km		
	12 Super Loki Datasonde 80 km		
	1 Taurus-Orion 180 km	Andoya Oct. 1980-Jan. 1981	
GREECE			
Greek National Committee for Space Research	7 Boosted Arcas approx. 95 km	NASA Ship Off Koroni, Greece May 1966	GSFC: Investigate relationship between the variation in ionization below 90 km and changes in solar UV and X-ray flux during total solar eclipse.
INDIA			
Indian Space Research Organization (ISRO) of the Department of Atomic Energy (DAE)	1 Nike-Apache 5 Nike-Apache 2 Nike-Apache 5 Nike-Apache	Thumba, India Nov. 1963 Jan./Nov. 1964 Mar. 1966 Mar. 1967	PRL: (1) Measure upper atmosphere winds by ground photography of illuminated sodium vapor released from rocket. (2) Measure upper atmosphere winds by ground photography of illuminated chemicals released from rocket. (3) Investigate relationship between wind shears and sporadic E by combining measurements under (2) above with electron density measurements.

## Cooperative Sounding Rocket Projects

Country and Cooperating Agency	Number, Type of Rocket, and Altitude	Launch Site and Date	Experimenter and Project Description
INDIA (Continued)			
ISRO (Continued)	4 Nike-Apache 150 km	Thumba Jan. 1964	University of New Hampshire: Investigate the equatorial electrojet at the Geomagnetic Equator by means of magnetometer instrumentation.
	30 Boosted Dart approx. 100 km	Thumba 1964-1966	Indian National Committee for Space Research (INCOSPAR): Meteorological rocket sounding payload supplementing the Indian Ocean expedition.
	1 Nike-Apache 3 Nike-Apache 150 km	Thumba Jul. 1966 Aug. 1968	PRL: Investigate the equatorial electrojet at the Geomagnetic Equator by means of magnetometer/Langmuir probe instrumentation.
	1 Nike-Apache 170 km	Thumba Feb. 1968	PRL: Measure neutral atmospheric winds above 85 km and measure electron densities in the upper atmosphere up to 160 km by means of trimethyl aluminum (TMA) and Zangmuir probe payloads.
	4 Nike-Apache approx. 250 km	Thumba Mar. 1968	ISRO/GSFC: Investigate electric fields in the equatorial electrojet by means of artificial barium-ion clouds.
	2 Boosted Arcas 85 and 95 km	Thumba Mar. 1968	ISRO/GSFC: Investigate equatorial electron density distribution in ionosphere D region by means of radio propagation experiments.
	2 Nike-Apache 150 km	Thumba Apr. 1968	US/India/Japan tripartite agreement: PRL/Institute of Space and Aeronautical Science (ISAS), Tokyo University. Measure absolute flux and energy spectrum and time variation of discrete X-ray sources (Crab Nebula, Scorpio, etc.). Also make a comprehensive survey of the southern sky.

## Cooperative Sounding Rocket Projects

Country and Cooperating Agency	Number, Type of Rocket, and Altitude	Launch Site and Date	Experimenter and Project Description
INDIA (Continued)			
ISRO (Continued)	1 Nike-Apache 150 km	Thumba Nov. 1968	PRL: Investigate sources of X-ray emissions in the southern sky.
	2 Nike-Apache 150 km	Thumba Apr. 1969	US/India/Japan tripartite agreement: PRL/ISAS, Tokyo University. Obtain data on changes in X-ray emission from the celestial X-ray source, SCO X-1, and compare it with corresponding changes in visual observations made from the ground.
	1 Nike-Apache 150 km	Thumba Mar. 1970	National Physical Laboratory (NPL), New Delhi: Measure electron and ion densities and Lyman-Alpha and X-ray flux by means of a riometer payload.
	4 Nike-Apache approx. 125-170 km 3 Nike-Tomahawk 280-320 km 4 Boosted Arcas 90 km	Thumba Jan./Mar. 1970 Mar. 1970 Mar. 1970	ISRO/GSFC: Study interrelation between ion composition, airglow emissions, and vertical drift velocities in the F region of the ionosphere.
	2 Nike-Apache 150 km	Thumba Jan. 1971	ISRO: Study of plasma instabilities of the D and E regions by Langmuir probes, and proton precession magnetometers.
	4 Nike-Apache 150-200 km	Thumba Apr. 1971	ISRO/University of Tokyo: Study of various ionospheric phenomena in the equatorial electrojet and electron densities by means of sodium vapor payloads, proton magnetometers, and high frequency capacitor probes.
	1 Nike-Apache 160 km	Thumba Apr. 1972	ISRO: Study of D and E region plasma instabilities by means of tip sensors on Langmuir probes.

## Cooperative Sounding Rocket Projects

Country and Cooperating Agency	Number, Type of Rocket, and Altitude	Launch Site and Date	Experimenter and Project Description
INDIA (Continued)			
Department of Space (DOS)	1 Nike-Apache 1 Indian Centaure approx. 120-150 km	Thumba Oct. 1972 <u>Sep. 1973</u>	DOS/GSFC/CNES: Describe steady-state electrojet and study plasma instabilities by means of simultaneous launchings of magnetometers, Langmuir and resonance probes, and electric field payloads.
ISRAEL			
National Committee for Space Research	1 Aerobee 150 1 Aerobee 150 2 Aerobee 150 approx. 280 km	White Sands, New Mexico Nov. 1965 <u>Oct. 1965</u> <u>Jun./Aug. 1967</u>	University of Tel Aviv: One of several experimenters providing special sampling surfaces to collect and analyze extraterrestrial dust particles as part of Project Luster.
ITALY			
Italian Space Commission (ISC)	8 Nike-Cajun and Nike-Asp 80-200 km	Sardinia <u>Jan./Apr./Sep. 1961</u> <u>Dec. 1962</u>	ISC: Measure upper atmosphere winds by ground photography of illuminated sodium vapor released from rocket.
	1 Nike-Tomahawk 280-320 km	San Marco Range, off coast of Kenya <u>Nov. 1971</u>	GSFC: Measure nitrogen and electron temperatures and densities in conjunction with a passage of the San Marco III satellite to provide calibration verification of its instruments.

## Cooperative Sounding Rocket Projects

Country and Cooperating Agency	Number, Type of Rocket, and Altitude	Launch Site and Date	Experimenter and Project Description
JAPAN			
Radio Research Laboratory (RRL)	3 Nike-Cajun 100-130 km 2 Aerobee 150 above 130 km 1 Javelin above 200 km	Wallops Island <u>Apr./May 1962</u>  Sep. 1963 <u>Oct. 1964</u>	RRL/GSFC: Combine Japanese swept frequency resonance probe with GSFC Langmuir probe for electron density and temperature determination.
Japanese Science and Technology Agency/ Japanese Meteorological Agency	10 MT-135 10 Boosted Arcas approx. 20-60 km	Wallops Island <u>Apr. 1967</u>	Japanese Science and Technology Agency/Japanese Meteorological Agency/Wallops Station: Obtain comparison data on operational characteristics of the rockets; gain additional information on diurnal wind and temperature cycles.
Institute of Space and Aeronautical Science (ISAS), University of Tokyo	2 Nike-Apache 150 km	Thumba, India <u>Apr. 1968</u>	US/Japan/India tripartite agreement: PRL/ISAS, Tokyo University. Measure absolute flux and energy spectrum and time variation of discrete X-ray sources (Crab Nebula, Scorpio, etc.). Also make a comprehensive survey of the southern sky.
	2 Nike-Apache 150 km	Thumba <u>Apr. 1969</u>	US/Japan/India tripartite agreement: PRL/ISAS, Tokyo University. Obtain data on changes in X-ray emission from the celestial X-ray source, SCO X-1, and compare it with corresponding changes in visual observations made from the ground.
Japanese Meteorological Agency	10 MT-135 approx. 60 km	Wallops Island <u>Mar. 1972</u>	Japanese Meteorological Agency/Wallops Station: WMO sponsored sounding rocket intercomparison tests among France, Japan, and NASA to improve the correlation of data returned by independent future launchings of various rocket systems.

## Cooperative Sounding Rocket Projects

Country and Cooperating Agency	Number, Type of Rocket, and Altitude	Launch Site and Date	Experimenter and Project Description
NETHERLANDS			
Netherlands Organization for Advancement of Pure Research	4 Nike-Apache up to 120 km	Coronie, Suriname <u>Sep. 1965</u>	Astronomical Observatory, University of Utrecht: Investigation of upper atmosphere equatorial winds by ground-based photograpy of illuminated sodium vapor released from payloads with simultaneous measurements of ionospheric drift (Mitra method).
Laboratory for Space Research (LRO)	1 Aerobee 150 approx. 200 km	White Sands, New Mexico <u>Oct. 1967</u>	LRO: Observation of the spatial distribution of solar X-ray sources by means of zone plate telescopes and a fine attitude control system.
NEW ZEALAND			
National Space Research Committee (NSRC)	1 Arcas	Birdling's Flat, New Zealand May 1963	University of Canterbury, New Zealand: Measure wind drift and turbulent diffusion in the D region of the ionosphere by rocket borne radio propagation measurements and by ground-based photograpy of illuminated aerosol released from rocket.
	2 Arcas 95 km	<u>Sep./Dec. 1964</u>	
	1 Boosted Arcas approx. 95 km	Karikari Peninsula, New Zealand <u>May 1965</u>	Range and experiment validation.
	6 Boosted Arcas approx. 95 km	Karikari Peninsula <u>May 1965</u>	(1) University of Canterbury: Differential absorption with ground-based sounders. (2) GSFC: Electron density by Faraday rotation technique.

## Cooperative Sounding Rocket Projects

Country and Cooperating Agency	Number, Type of Rocket, and Altitude	Launch Site and Date	Experimenter and Project Description
NORWAY			
Norwegian Committee for Space Research (NCSR), jointly with Royal Technical University of Denmark	<p>1 Nike-Cajun</p> <p>1 Nike-Apache</p> <p>2 Nike-Cajun above 90 km</p> <p>2 Nike-Cajun above 100 km</p> <p>1 Nike-Cajun</p> <p>1 Nike-Apache</p> <p>3 Nike-Apache above 130 km</p> <p>4 Nike-Apache up to 185 km</p> <p>1 Nike-Apache</p> <p>2 Nike-Apache above 180 km</p>	<p>Wallops Island Dec. 1961</p> <p>Jun. 1962</p> <p>Mar./Apr. 1963</p> <p>Andoya, Norway Aug./Dec. 1962</p> <p>Sep. 1963</p> <p>Sep. 1963</p> <p>Mar. 1964</p> <p>Andoya Mar./Nov. 1965</p> <p>Jun. 1966</p> <p>Mar. 1967</p>	<p>Norwegian Defense Research Establishment (NDRE)/Royal Technical University of Denmark (Andoya launchings), GSFC/NDRE (Wallops launchings): Measure D and E region electron and ion density and electron collision frequency by radio absorption experiment, Faraday rotation experiment, and RF impedance and conductivity probes. Lyman-Alpha monitor (Wallops) and energetic particles experiment (Andoya) also included.</p>
NCSR	<p>4 Boosted Arcas up to 90 km</p> <p>2 Boosted Arcas approx. 95 km</p> <p>1 Nike-Apache up to 185 km</p> <p>1 Nike-Apache up to 180 km</p> <p>3 Sidewinder Arcas up to 80 km</p> <p>1 Sidewinder-Arcas approx. 85 km</p>	<p>Andoya Mar./Dec. 1965</p> <p>Andoya Mar. 1965</p> <p>Andoya Mar. 1965</p> <p>Andoya Mar. 1965</p> <p>Andoya Aug./Oct. 1967</p> <p>Nov. 1968</p>	<p>NDRE/GSFC: Support for ground-based cross-modulation studies of the ionosphere using Faraday rotation technique.</p> <p>US/Norway/Sweden tripartite agreement: Uppsala Ionospheric Observatory/NDRE. Measure ion and electron densities in D region of ionosphere. Measure winds and sodium emissions in aurorae. Measure auroral phenomena by observing the effects of artificial shock wave created by a high-energy explosive charge.</p> <p>NDRE/GSFC: Launch experiments into Polar Cap Absorption (PCA) event to study relationships between sudden increase in radio wave absorption and flux of low energy incoming particles or, in absence of PCA event, modify experiments to obtain auroral absorption date.</p>

## Cooperative Sounding Rocket Projects

Country and Cooperating Agency	Number, Type of Rocket, and Altitude	Launch Site and Date	Experimenter and Project Description
NORWAY (Continued)			
Norwegian Council for Scientific and Industrial Research (NTNF)	1 Nike-Apache 133 km	Andoya Mar. 1966	NDRE/GSFC: Study the ionic composition of the D region with an ion-spectrometer payload.
	6 Nike-Tomahawk *approx. 320 km **approx. 230 km	Andoya Aug./Sep. 1967	NTNF/GSFC: Three pairs of barium ion cloud and instrumented payloads launched to compare the relatively new barium technique of measuring electric fields with proven methods of direct field measurement.
	5 Nike-Tomahawk *approx. 320 km **approx. 230 km	Andoya Sep./Oct. 1968	NTNF/GSFC: Each instrumented payload (two NTNF) was launched within minutes of a barium payload (three NASA) to study dynamics of the auroral ionosphere by observing the electric and magnetic fields and the charged particle environment during auroral activity.
	2 Nike-Tomahawk up to 280 km	Andoya Feb./Mar. 1970	University of Bergen/Norwegian Institute for Cosmic Physics/ NDRE/GSFC: Integrated auroral studies including neutral particle and ion composition, electric fields, photometry at selected wavelengths, and high and low energy particle density and fluxes.
	1 Nike-Tomahawk approx. 213 km 1 Nike-Tomahawk approx. 250 km	Andoya Nov. 1970 Andoya Jan. 1971	NDRE/GSFC: Integrated transauroral studies including low energy particles, electron densities, and auroral emissions at selected wavelengths.
	1 Nike-Tomahawk approx. 190 km 1 Nike-Tomahawk approx. 278 km	Andoya Jan. 1972 Andoya Jan. 1973	NDRE/GSFC: Study of plasma resonances in the auroral and transauroral ionospheric F layer and of variations in low energy particle fluxes in pulsating aurorae.

\* Barium ion cloud payload

\*\* Instrumented payload

## Cooperative Sounding Rocket Projects

Country and Cooperating Agency	Number, Type of Rocket, and Altitude	Launch Site and Date	Experimenter and Project Description
NORWAY (Continued)			
NTNF (Continued)	2 Nike-Tomahawk approx. 220 km	Andoya Feb. 1972 <u>Jan. 1973</u>	Norwegian Institute for Cosmic Physics: Study of sources and effects in upper atmosphere during strong line emission in Auroral Zone.
	1 Nike-Apache approx. 200 km	Andoya Jan. 1972	
	1 Nike-Tomahawk approx. 250 km	Andoya <u>Feb. 1973</u>	NDRE/NOAA: Study relationship between particle streams and electric fields.
	1 Nike-Cajun approx. 110 km	Andoya May 1972	
	1 Nike-Apache approx. 150 km	Andoya <u>May 1972</u>	NDRE/University of Maryland: Study relativistic electron precipitation events.
	2 Nike-Tomahawk approx. 240 km approx. 250 km	Andoya Jan. 1974 <u>Dec. 1974</u>	NDRE/University of Maryland/GSFC: Continue studies of electron precipitation and DC electric fields oriented along the geomagnetic field vector inside the ionospheric polar cap F layer.
	1 Nike-Tomahawk approx. 210 km	Andoya Nov. 1976	
	1 Terrier-Malemute approx. 530 km	Andoya <u>Nov. 1976</u>	Norwegian Institute of Cosmic Physics/University of Bergen/GSFC: Observe electric field reversal associated with the Harang discontinuity, in particular the spatial variation of the electric field, optical auroral emissions, and particles are to be determined and related to auroral substorm parameters.
	1 Nike-Tomahawk approx. 220 km	Andoya <u>Feb. 1976</u>	NDRE/GSFC: To develop an electron sonde for studies of reflected electrons and study the geophysical effects of the electron pulse.

## Cooperative Sounding Rocket Projects

Country and Cooperating Agency	Number, Type of Rocket, and Altitude	Launch Site and Date	Experimenter and Project Description
NORWAY (Continued)			
	1 Nike-Tomahawk 202 km	Andoya Jan. 1980	University of Oslo/University of Bergen/NRDE/Uppsala Ionospheric Observatory/Royal Norwegian Institute of Technology/NOAA: To investigate the physical processes involved in generating pulsating auroral phenomena.
	1 Nike Tomahawk*	Andoya Jan. 1980	University of Oslo/NRDE/Swedish Royal Institute of Technology/Danish Meteorological Institute/DSRI/Uppsala Ionospheric Observatory/University of Bergen/University of New Hampshire/NOAA: To study plasma instabilities and irregularities in the auroral E-region.
	3 Taurus-Orion 120 km	Andoya Oct. 1980	University of Oslo/University of Bergen/NRDE/GSFC: To measure the vector electric field and associated electrodynamic parameters in the middle atmosphere.
	3 Orion approx. 85 km		
	14 Super Loki Datasonde 82 km		
	4 Super Loki Dart Blunt Probe 65 km		
	1 Nike Tomahawk approx. 205 km	Andoya Feb. 1981	NRDE/University of Bergen/University of Oslo/Technical University of Graz/GSFC/University of New Hampshire: To investigate the interactions between the beam from a rocket borne electron and accelerator and the ambient plasma which lead to the production of high fluxes of less than 2 KeV electrons.
	1 Terrier-Malemute approx. 640 km	Andoya Jan./Feb. 1982	NRDE/University of Bergen/University of Oslo/University of New Hampshire/MPI, Lindau/GSFC: To study the detailed latitudinal profiles of particles and fields within the newly expanded, high latitudinal precipitation region during the poleward leap stage of a magnetospheric substorm.

\* unsuccessful launch

## Cooperative Sounding Rocket Projects

Country and Cooperating Agency	Number, Type of Rocket, and Altitude	Launch Site and Date	Experimenter and Project Description
PAKISTAN			
Space and Upper Atmosphere Research Committee (SUPARCO)	2 Nike-Cajun	Sonmiani Beach, Pakistan <u>Jun. 1962</u> <u>May 1963</u>  <u>Apr./Nov./Dec. 1964</u> <u>Feb. 1966</u>	SUPARCO: Measure upper atmosphere winds by ground-based photography of illuminated sodium vapor released from payload.
	1 Nike-Cajun 8-125 km		
	3 Nike-Apache		
	2 Nike-Apache 125-200 km		
	32 Boosted Dart		
SUPARCO, jointly with UK Science Research Council	2 Nike-Cajun 80-125 km	Sonmiani Beach <u>1964-1967</u>   Sonmiani Beach <u>Apr. 1965</u> <u>Mar. 1966</u> <u>Mar./Apr. 1966</u> <u>Nov. 1967</u> <u>Mar. 1970</u>	SUPARCO: Meteorological rocket soundings supplementing the International Indian Ocean Expedition.   US/Pakistan/UK tripartite agreement: GSFC/SUPARCO/University College, London. Measure wind, temperature, pressure, and density using grenade technique, between 50 and 150 km.
	1 Nike-Cajun		
	2 Nike-Apache		
	1 Nike-Apache		
	2 Nike-Cajun 80-125 km		
PERU			
Geophysical Institute of Peru (IGP)	4 Nike-Tomahawk approx. 500 km	Chilca Range, Peru <u>May/Jun. 1975</u>	Dudley Observatory/University of Pittsburgh/University of Illinois/Pennsylvania State University/University of Denver/Geophysics Corporation of America: Ionospheric and magnetospheric studies at a site on the Geomagnetic Equator. In addition, twelve balloons were flown as a part of this Project "Antarqui."
	8 Nike-Apache approx. 200 km		
	7 Super-Arcas approx. 150 km		
	10 Super-Loki approx. 80 km		

## Cooperative Sounding Rocket Projects

Country and Cooperating Agency	Number, Type of Rocket, and Altitude	Launch Site and Date	Experimenter and Project Description
SPAIN			
National Space Research Commission (CONIE)	10 Boosted Dart	Huelva, Spain Oct./Dec. 1966	CONIE: Measure wind and temperature using payload or instrumented sondes. Beginning in 1971, launchings conducted in conjunction with EXAMETNET.
	6 Boosted Dart	Jan./Feb. 1968	
	13 Boosted Dart	Jan./Dec. 1968	
	14 Boosted Dart	1969	
	29 Boosted Dart	1970	
	23 Boosted Dart	1971	
	26 Boosted Dart	1972	
	24 Boosted Dart	1973	
	7 Boosted Dart	1974	
	1 Boosted Dart	1975	
	2 Boosted Dart	1976	
	48 Boosted Dart	1977	
	14 Boosted Dart	1978	
	20-60 km		
	4 Nike-Cajun 80-125 km	Huelva Mar./May 1969	National Institute for Aerospace Technology (INTA): Measure wind, temperature, pressure, and density using grenade technique.
	4 Nike-Cajun 80-125 km	Huelva Apr./May 1971	CONIE: Temperature, pressure density and wind measurement the stratosphere and mesosphere.
	1 Nike-Cajun 85 km	Huelva Jul. 1972	CONIE: Ion composition studies of the ionospheric D and E regions.
	1 Nike-Apache 122 km		
	2 Nike-Apache 120 km	Huelva 1981	CONIE: Particles, fields and neutral atmosphere studies in connection with the Perseids meteor shower.
	2 Nike-Cajun 85 km		

## Cooperative Sounding Rocket Projects

Country and Cooperating Agency	Number, Type of Rocket, and Altitude	Launch Site and Date	Experimenter and Project Description
SWEDEN			
Swedish Space Research Committee (SSRC)	1 Arcas 80 km	Jokkmokk, Sweden Aug. 1961	University of Stockholm: (1) Measure winds during occurrence of noctilucent clouds by optical tracking of smoke trail created by release of aerosol powder from rocket. (2) Measure upper atmosphere temperature, wind, pressure, and density during occurrence of noctilucent clouds by means of rockets instrumented with explosive charges and associated electronics.
	4 Nike-Cajun up to 100 km	Kronogard, Sweden Aug. 1962	
	4 Nike-Cajun up to 100 km	Kronogard Aug. 1963	University of Stockholm/Cambridge Research Laboratory: (1) Direct sampling of noctilucent clouds with recoverable container. Also energetic particles experiment (Kiruna Geophysical Observatory). (2) Measure upper atmosphere temperature, wind, pressure, density during occurrence of noctilucent clouds by rockets instrumented with explosive charges (3) Particle collection and scattered light photometry in noctilucent clouds.
	4 Nike-Apache up to 120 km	Aug. 1964	
	4 Nike-Cajun up to 120 km	Aug. 1964	
	3 Boosted Arcas approx. 95 km	White Sands Oct./Dec. 1963	
	1 Boosted Arcas approx. 95 km	Wallops Island Mar. 1964	Uppsala Ionospheric Observatory: Measure upper atmosphere winds by ground-based photography of sodium-lithium releases from payload.
	1 Aerobee 150 approx. 180 km	White Sands, New Mexico Nov. 1965	Uppsala Ionospheric Observatory: One of several experimenters providing special sampling surfaces to collect and analyze extraterrestrial dust particles as part of Project Luster.

## Cooperative Sounding Rocket Projects

Country and Cooperating Agency	Number, Type of Rocket, and Altitude	Launch Site and Date	Experimenter and Project Description
SWEDEN (Continued)			
SSRC (Continued)	2 Boosted Arcas approx. 95 km	Andoya, Norway Mar. 1965	US/Sweden/Norway tripartite agreement: Uppsala Ionospheric Observatory/NDRE. Measure ion and electron densities in D region of ionosphere. Measure winds and sodium emissions aurorae. Measure auroral phenomena by observing the effects of artificial shock wave created by a high-energy explosive charge.
	2 Nike-Apache up to 120 km	Andoya Mar. 1965	
	1 Boosted Arcas II approx. 145 km	Kiruna Oct. 1968	Uppsala Ionospheric Observatory: Measure ion and electron densities in D and lower E regions of ionosphere under varying auroral conditions.
	2 Boosted Arcas II approx. 145 km	Andoya Jan. 1969	
	4 Nike-Cajun up to 100 km	Kiruna Jan. 1969	US/Sweden/UK tripartite agreement: GSFC/University of Stockholm/University College, London. Measure wind, temperature, pressure, and density using grenade technique.
	2 Nike-Apache approx. 100 km	Kiruna Aug. 1970	
Swedish Board for Space Activities (SBSA)	1 Petrel approx. 100 km	Kiruna Aug. 1970	Dudley Observatory/GSFC: Particle collection, scattered light photometry, and electric field measurements in noctilucent clouds. (First Campaign).
	1 Nike-Tomahawk approx. 200 km	Kiruna Feb. 1972	Uppsala Ionospheric Observatory: Ion and electron fluxes and electron energy spectra measurements in noctilucent clouds. (Second Campaign).
	3 Nike-Apache approx. 100 km	Kiruna Oct. 1972	Royal Institute of Technology/Kiruna Geophysical Observatory/Uppsala Ionospheric Observatory/Lund Observatory/University of California at Berkeley: Electric field and current measurements, electron and proton spectra photometry, and micrometeoroid detection during auroral events.
			Dudley Observatory/GSFC: Particle collection, scattered light photometry and plasma detection in connection with the Giacobini-Zinner meteor shower.

## Cooperative Sounding Rocket Projects

Country and Cooperating Agency	Number, Type of Rocket, and Altitude	Launch Site and Date	Experimenter and Project Description
SWEDEN (Continued)			
SBSA (Continued)	2 Nike-Apache approx. 100 km	<u>Kiruna Aug. 1973</u>	Dudley Observatory/GSFC/University of Stockholm: Direct sampling, photometry, and mass spectrometer studies in noctilucent clouds.
	1 Nike-Cajun approx. 80 km		
	2 Nike-Apache approx. 100 km	<u>Kiruna Mar. 1975</u>	University of Stockholm/GSFC: Atomic oxygen measurements nightglow components, ozone, nitrous oxide (NO), and water vapor.
	1 Nike-Tomahawk approx. 200 km	<u>Kiruna Feb. 1977</u>	Uppsala Ionospheric Observatory/GSFC: Magnetosphere/ionosphere interactions and mechanisms for energetic particle participation.
	2 Super-Arcas approx. 80 km	<u>Kiruna Feb. 1977</u>	University of Houston: Measure the flux of bremsstrahlung X-rays following explosive detonation in the ionosphere, in conjunction with Nike-Tomahawk campaign.
	1 Nike-Orion 190 km	<u>Kiruna Apr. 1978</u>	Institute of Meteorology, University of Stockholm: Observe UV emission from NO in the aurora, investigate excitation mechanisms and the changes in NO concentration associated with auroral processes.
	1 Nike-Orion 150 km	<u>Kiruna Aug. 1979</u>	Stockholm/Uppsala Ionospheric Observatory/Johns Hopkins University: Studies of the photochemistry of nitric oxide at high latitude in particular relation to auroral processes.
	1 Nike-Orion 150 km	<u>Kiruna Aug. 1979</u>	Swedish Space Corporation/NASA: Technological test of feasibility of launching a Nike-Orion sounding rocket from the Skylark Tower at Kiruna.

## Cooperative Sounding Rocket Projects

Country and Cooperating Agency	Number, Type of Rocket, and Altitude	Launch Site and Date	Experimenter and Project Description
SWEDEN (Continued)			
SBSA (Continued)	1 Nike-Black Brant V-C 410 km	Kiruna <u>Sept. 1979</u>	Uppsala Ionospheric Observatory/Royal Institute of Technology/ Kiruna Geophysical Institute/Cornell University/University of Houston: Coordinated sounding rocket and satellite measurements of barium ions to study acceleration and scattering of charged particles on auroral field lines.
	1 Nike Black Brant V-C approx. 300 km	Kiruna Jan./Feb. 1981	Stockholm University/Cornell University: To study the properties of dust grains and the gas-to-dust ratio prevailing in the target dust cloud, using a pointed infrared astronomical telescope.
	1 Black Brant X approx. 750 km	Wallops Island Spring 1981	Swedish Space Corporation/GSFC: Flight test of three-stage Black Brant vehicle.
	2 Black Brant X approx. 750 km	Cape Parry Dec. 1981	University of Texas at Dallas/DSRI/Danish Meteorological Institute/ the Swedish Royal Institute of Technology/Aerospace Corporation/ Southwest Research Institute: To compare mechanisms responsible for the production of Birkeland currents and the associated energiz- ation of charged particles in the pre- and post-noon magnetospheric cleft.
SWITZERLAND			
Federal Department of the Interior	1 Aerobee 170 approx. 250 km 1 Aerobee 170 approx. 250 km	White Sands Mar./Apr. 1981 Mar./Apr. 1982	Physikalische-Meteorologisches Observatorium Davos/GSFC: To study the rate at which solar energy is incident on the earth's atmosphere.

## Cooperative Sounding Rocket Projects

Country and Cooperating Agency	Number, Type of Rocket, and Altitude	Launch Site and Date	Experimenter and Project Description
UNITED KINGDOM			
British National Committee for Space Research	2 Nike-Apache up to 120 km	Wallops Island <u>Jul./Nov. 1964</u>	University of Birmingham/University of Illinois/Geophysics Corporation of America: Combine British radio frequency capacitance probe with Langmuir probe, radio propagation experiment, and energetic particle sensors to check reliability of ionospheric measurement techniques.
Science Research Council (SRC)	1 Aerobee 150 1 Aerobee 150 1 Aerobee 150 approx. 280 km	White Sands, New Mexico <u>Nov. 1964</u> <u>Nov. 1965</u> <u>Oct. 1966</u>	Birkbeck College: One of several experimenters providing special samplings surfaces to collect and analyze extraterrestrial dust particles as part of Project Luster.
	2 Nike-Cajun 3 Nike-Apache 1 Nike-Apache 2 Nike-Cajun 80-200 km	Sonmiani Beach, Pakistan <u>Apr. 1965</u> <u>Mar./Apr. 1966</u> <u>Nov. 1967</u> <u>Mar. 1970</u>	US/UK/Pakistan tripartite agreement: GSFC/University College, London/SUPARCO. Measure wind, temperature, pressure, and density using grenade technique, between 50 and 150 km.
	4 Nike-Cajun up to 100 km	Kiruna, Sweden <u>Jan. 1969</u>	US/UK/Sweden tripartite agreement: GSFC/University College, London/University of Stockholm. Measure wind, temperature, pressure, and density using grenade technique.
	3 Skylark 200 km	Woomera, Australia <u>Jun. 1973</u> <u>Aug. 1973</u> <u>Dec. 1973</u>	University of Leicester: Conduct of up to three stabilized Skylark sounding rockets to study X-ray emissions from the solar corona using very high resolution spectroscopy. These observations were coordinated with Apollo telescope operations on Skylab.

## Cooperative Sounding Rocket Projects

Country and Cooperating Agency	Number, Type of Rocket, and Altitude	Launch Site and Date	Experimenter and Project Description
UNITED KINGDOM (Continued)			
SRC (Continued)	2 Pajute-Tomahawk 160 km	Wallops Island <u>Jun. 1974</u>	University College, London/GSFC: To conduct electric field measurements as part of the ALADDIN campaign to obtain a complete description of the neutral and ionized atmosphere in a 24-hr period.
	1 Skylark 200 km	Woomera <u>Oct. 1974</u>	Mullard Space Science Laboratory/GSFC: Soft X-ray studies of galactic sources with a grazing incidence telescope.
	2 Skylark 200 km	Andoya, Norway <u>1977</u>	Mullard Space Science Laboratory/GSFC: Measurements of field aligned currents in the high latitude magnetosphere synoptically with measurements from the ESA Geostationary Scientific Satellite (GEOS).
	1 Skylark 200 km	Woomera <u>Apr. 1977</u>	Mullard Space Science Laboratory/MSFC: Continuation of soft X-ray studies of galactic sources with a grazing incidence telescope.
	1 Aries approx. 500 km	White Sands <u>Sept. 1980</u>	Mullard Space Science Laboratory/LPARL: Determination of the spectra and angular structure of extended sources of X-ray emission using an imaging X-ray proportional counter with a one-mirror configuration.
	1 Aries approx. 500 km	White Sands 1982	Mullard Space Science Laboratory/LPARL: Determination of the spectra and angular structure of extended sources of X-ray emission using imaging X-ray proportional counter with a 3-mirror configuration under development for Spacelab application.

## Joint Development Projects

Country or Organization	Delivery Date	Program Description
CANADA		
<ul style="list-style-type: none"> <li>Space Shuttle-Attached Remote Manipulator System (RMS)</li> </ul>	1980	National Research Council of Canada (NRCC) undertook in June 1975 to design, develop, and manufacture the RMS at Canadian expense. The RMS will deploy payloads from the Shuttle payload bay, retrieve them, and perform certain payload servicing operations in space.
EUROPEAN SPACE AGENCY (ESA)		
<ul style="list-style-type: none"> <li>Heat Pipe</li> </ul>	<u>1973</u>	European Space Technology Center (ESTEC) designed, fabricated, and delivered to NASA an experimental bendable miniature heat pipe for integration into a Black Brant sounding rocket payload launched in 1974.
<ul style="list-style-type: none"> <li>Spacelab</li> </ul>	1980-81	<p>Nine member countries of ESA - Belgium, Denmark, France, Germany, Italy, the Netherlands, Spain, Switzerland, and the United Kingdom - entered into an agreement in September 1973 with the United States to undertake, as an ESA special project funded entirely in Europe (possibly in excess of \$800 million), to design, develop, manufacture, and deliver to NASA, a Space Laboratory (Spacelab) for use with the Space Shuttle. Austria, an ESA observer, is also contributing to the Spacelab development.</p> <p>The Spacelab will consist of a pressurized laboratory module, permitting experimenters to work in normal shirt-sleeve environment, and a platform or pallet to support telescopes and other instruments requiring direct space exposure and an Instrument Pointing System (IPS) for experiments requiring precise pointing. The module and pallet, separately or together, will be carried to orbit and remain in the Space Shuttle Orbiter's payload bay for missions lasting 7 to 30 days.</p> <p>ESA will deliver the first Spacelab Flight unit about one year before the first Spacelab mission to be flown on the Shuttle, currently planned for 1983. NASA will purchase any similar additional required Spacelabs from Europe on agreed terms.</p> <p>Experimental objectives of the first Spacelab mission in 1983 are jointly planned by NASA/ESA. Selection of the initial experiment complement was made in February 1977.</p>
<ul style="list-style-type: none"> <li>○ Completed Project</li> <li>● Current</li> </ul>		

## Joint Development Projects

Country or Organization	Delivery Date	Program Description
GERMANY		
o Heat Pipes	<u>1973</u>	German Space Research Corporation (GSFC) designed, fabricated, and delivered to NASA an experimental flat plate vapor chamber heat pipe for integration into a Black Brant sounding rocket payload in 1974.
o Sounding Rocket Recovery System	<u>1973</u>	German Aerospace Research and Test Establishment (DFVLR)/NASA Goddard Space Flight Center (GSFC)/Sandia Laboratories: Joint development to upgrade sounding rocket recovery systems to 453.6 kg (1000 lb) capacity by rocket flight testing in early 1973.
o Aries	<u>1975</u>	DFVLR/GSFC: Joint development of the Aries heavy sounding rocket system using United States (US) surplus vehicles. Vehicles with shared technology tasks and instrumentation. Test flight conducted in August 1975.
SWEDEN		
o Boost Control System	<u>1976</u>	Swedish Space Corporation (SSC)/GSFC: Joint development of a Boost Control System (BCS) designed to reduce sounding rocket dispersion. BCS provided by SSC; Black Brant V-C sounding rocket furnished by NASA. Launched January 1976.

## Cooperative Ground-Based Projects

Project	Number of Countries	Description
REMOTE SENSING		
o Preliminary Cooperative Projects 1968-1971	2	In 1968, NASA initiated cooperative remote sensing research projects with Brazil's Institute of Space Research (INPE) and the Mexican National Commission on Outer Space (CONEE). These projects emphasized the development of airborne remote sensing techniques and systems in anticipation of the 1972 launching of NASA's Earth Resources Technology Satellite -1 (ERTS-1), now referred to as Landsat-1.
o Investigations Programs 1972-1978	46*	Researchers from 46 countries and 4 international organizations successfully participated in the Landsat-1, Landsat-2, Skylab Earth Resources Experiment Package (EREP) investigations programs, and bilateral research projects analyzing Earth resources data and provided NASA with periodic reports on their work. The reports, covering a variety of disciplines, have been published in proceedings of symposia sponsored by NASA.
Foreign Landsat Ground Stations Landsat-1 1972** Landsat-2 1975 Landsat-3 1978 Landsat-D 1982 (planned)	11***	Because of the growing benefits resulting from the Landsat investigations program and in order to obtain more complete and current Landsat data, the following agencies have concluded agreements with NASA under which they establish Landsat receiving, processing, and data distribution facilities. In exchange for direct access to Landsat-type satellites, these cooperating agencies have agreed to (a) pay NASA a nominal access fee, (b) make data available to NASA under certain circumstances, and (c) make the Landsat data they acquire publicly available at reasonable charges.
Canada		
• Department of Energy, Mines and Resources (DEMR) (Canada Centre for Remote Sensing - CCRS)	1971 Renewed 1976 Renewed 1980	Prince Albert, Saskatchewan, 1972 St. John's, Newfoundland, 1977

\* See Appendix B for list of countries.

\*\* Ceased collecting data in 1977.

\*\*\* Countries operating or establishing Landsat Ground stations under agreements with NASA (Note: Two countries, Italy and Sweden are operating stations under a single NASA/ESA agreement).

o Completed Project  
• Current

## Cooperative Ground-Based Projects

Project	Number of Countries	Description	Agreement Signed	Station Location and Operational Date
REMOTE SENSING (Continued)				
Foreign Landsat Ground Stations (Continued)				
<ul style="list-style-type: none"> <li>Brazil <ul style="list-style-type: none"> <li>Brazilian Commission for Space Activities, now Institute of Space Research (INPE)</li> </ul> </li> </ul>			1973 Renewed 1976 Renewed 1978	Cuiaba, 1974
<ul style="list-style-type: none"> <li>Italy <ul style="list-style-type: none"> <li>Telespazio (Superseded by agreement with European Space Agency (ESA))</li> </ul> </li> </ul>			1974	Fucino (Rome), 1976
<ul style="list-style-type: none"> <li>Iran <ul style="list-style-type: none"> <li>Planning and Budget Organization</li> </ul> </li> </ul>			1974 Expired 1978	Shahdasht (Tehran)*
<ul style="list-style-type: none"> <li>Zaire <ul style="list-style-type: none"> <li>ERTS - Zaire</li> </ul> </li> </ul>			1975 Expired 1979	Kinshasa**
<ul style="list-style-type: none"> <li>Chile <ul style="list-style-type: none"> <li>University of Chile</li> </ul> </li> </ul>			1975 Expired 1979	Santiago**
<ul style="list-style-type: none"> <li>Argentina <ul style="list-style-type: none"> <li>National Commission for Space Research (CNIE)</li> </ul> </li> </ul>			1976 Renewed 1981	Mar Chiquita, 1980
<ul style="list-style-type: none"> <li>ESA (Supersedes agreement with Italy)</li> </ul>			1978	Fucino (Rome), 1976 Kiruna, Sweden, 1978

\* Status unknown.

\*\*Funding not yet available.

## Cooperative Ground-Based Projects

Project	Number of Countries	Description	Agreement Signed	Station Location and Operational Date
REMOTE SENSING (Continued)				
Foreign Landsat Ground Stations (Continued)				
India				
• National Remote Sensing Agency			1978	Hyderabad, 1980
Japan				
• National Space Development Agency (NASDA)			1979	Saitama, 1979
Australia				
• Department of Science and the Environment			1979	Alice Springs, 1980
Thailand				
• National Research Council of Thailand (NRCT)			1979	Bangkok, 1982 (planned)
Union of South Africa				
• Council for Scientific and Industrial Research (CSIR)			1980	Hartebeesthoek, 1980
China				
• Chinese Academy of Sciences (CAS)			1980	Near Beijing, 1982-83, (planned)
• Exchange of Computer Programs for Remote Sensing Image Analysis	1	NASA and Canadian DEMR agreed in 1978 to exchange certain image analysis computer programs for use in analyzing Landsat and other remotely sensed data.		
• Applications Explorer Mission-A (Heat Capacity Mapping Mission-	9	Data-use investigations were undertaken with France, Italy, Spain, Switzerland, Australia, Canada, Germany, the Commission of European Communities (CEC), and the United Kingdom in 1978. These investigations studied Earth surface and subsurface phenomena through thermal inertia measurements operating over the same area during day and night times. To support European data-use investigations, ESA established a direct reception facility at Lannion, France, to receive and process HCM data of Europe under an agreement concluded with NASA in 1978. The satellite ceased operation in September 1980. Data analysis and research are continuing.		

## Cooperative Ground-Based Projects

Project	Number of Countries	Description
REMOTE SENSING (Continued)		
<ul style="list-style-type: none"> <li>Seasat Data Use and Direct Reception 1978-present</li> </ul>	2	<p>ESA and the Canadian DMR both proposed Seasat data-use investigations which required the real-time reception of Seasat sensor data in various regions. These proposals were accepted and ground stations established at Oakhanger, UK, and Shoe Cove, Newfoundland, in 1978. Both stations received Seasat data beginning shortly after its launch in July 1978 and until its failure in October 1978. Data analysis and research are continuing.</p>
<ul style="list-style-type: none"> <li>Ocean Dynamics Study Project 1979-80</li> </ul>	1	<p>Joint study with Japan's Science and Technology Agency (STA) to relate two-dimensional patterns of Pacific Ocean surface features as derived from Seasat satellite data with the three-dimensional subsurface structures measured by hydrographic, tide gauge, and expendable bathythermograph instruments, and including gravity and current data for the selected areas of interest.</p>
<ul style="list-style-type: none"> <li>Winds and Waves Study Project 1980-81</li> </ul>	1	<p>Joint study with Japan's Science and Technology Agency (STA) of winds and waves associated with typhoons in the North Pacific during 1978, by means of correlation of Seasat satellite data on winds, waves and temperature with sea surface truth data collected by Japan.</p>
<ul style="list-style-type: none"> <li>Snow Properties Study Project 1980-81</li> </ul>	1	<p>Joint study with Japan's Science and Technology Agency (STA) to establish a general method, applicable to various topographical areas, of effective use of satellite data to snow cover extent, snow depth, snow equivalent water, snow density, snow surface temperature and snow cover physics, by use of satellite and surface truth data for selected test sites in US and Japan.</p>
<ul style="list-style-type: none"> <li>Evaporation Study Project 1980-82</li> </ul>	1	<p>Joint study with Japan's Science and Technology Agency (STA) to establish an effective method for applying data acquired by satellite to estimation of evaporation from lakes and evapo-transpiration from neighboring land areas, by use of coordinated satellite and surface truth data for selected test sites in US and Japan.</p>

## Cooperative Ground-Based Projects

Project	Number of Countries	Description
COMMUNICATION SATELLITE PROJECTS		
o Relay, Telstar and Synchronous Communications Satellite (Syncom) 1962-1964	12	Projects Relay, Telstar, and Syncom demonstrated the feasibility of transoceanic communications via active repeater satellites by picking up and amplifying signals received from ground stations and retransmitting them to Earth. The following countries provided ground stations for cooperative programs in the testing of US experimental communications satellites: Brazil, France, Italy, and UK (1962); Germany and Japan (1963); Denmark, Norway, and Sweden operating a joint receiving facility, Spain (1964); and Canada (1966). Nearly all stations conducted experiments involving transmission of telephone, telegraph, and high speed data as well as intercontinental television experiments. This cooperation extended and continued under the Applications Technology Satellites (ATS). President Kennedy spoke with the Prime Minister of Nigeria, which hosted the USS Kingsport as the African terminal for Syncom 2 in Lagos Harbor. In October 1964, Syncom 3 carried live television coverage of the Olympic Games from Japan.
Application Technology Satellites (ATS)	7	
• <u>ATS-1 Dec. 1966</u>		Australia, through Qantas, participated in a very high frequency (VHF) aeronautical communications experiment using a VHF transponder and conducted super high frequency (SHF) and VHF tests in 1967-1968. Japan received spin scan cloud cover pictures during severe storm periods in 1971-1973. ATS-1 is also being used in experimental programs beginning in 1971 for transmission of educational materials by the University of Hawaii to universities in New Zealand, Fiji, Papua New Guinea, and Tonga. The University of the South Pacific is making similar transmissions to its five campuses in the South Pacific. Canada, in cooperation with NASA Goddard Space Flight Center (GSFC), conducted an experiment in 1972 to observe the effects of signals at high latitudes and low elevation angles. Japan's Radion Research Laboratory (RRL) in coordination with GSFC controlled the NASA ATS-1 spacecraft on an experimental basis from Japan during 1974-1976. The University of Sydney (Australia) and Tohoku University (Japan) initiated in 1979 an experiment utilizing ATS-1 in synchronous packet transmission.

## Cooperative Ground-Based Projects

Project	Number of Countries	Description
COMMUNICATION SATELLITE PROJECTS (Continued)		
ATS (Continued)		
o <u>ATS-3 Nov. 1967</u>	10	ATS-3 was used by Germany and the Netherlands to conduct maritime communications and navigation experiments by the UK in VHF aircraft and for surface communications experiments and to evaluate the use of chirp modulation to combat multipath effects and doppler shifts on radio link transmissions, and by Norway in an experiment to determine the effectiveness of collecting oceanographic and meteorological data from sensors on instrumented buoys. Brazil and Stanford University used ATS-3 in an experiment involving voice and data transmissions of educational programs. ATS-3 has been used to transmit data from a Sea Robin buoy in Bermuda, to assist in making estimates of rainfall during hurricanes in Venezuela and Honduras in an experiment involving voice talkback in Jamaica and Barbados.
o <u>ATS-5 Aug. 1969 (malfunctioned)</u>	1	ATS-5 was used by Canada in 1970 to correlate data obtained from ground magnetic measurements at the conjugate point in Canada and to obtain millimeter wave propagation.
o <u>ATS-6 May 1974-1979</u>		
o <u>Position Location and Aircraft Communication Experiment (PLACE) 1974-1975</u>	2	Canada's Department of Communications (DOC) and ESA participated in experiments to obtain engineering data and practical experience for determining the operational feasibility of air traffic control and maritime satellite systems operating in the aeronautical L-Band.
o <u>Search and Rescue Experiment 1975</u>	3	In a joint experiment with Canada, Germany and ESA, a typical search and rescue incident was staged using a buoy in the vicinity of the Azores to transmit a signal via ATS-6 to the NASA terminal in Rosman, North Carolina, Rosman then alerted rescue vessels to the location of the buoy.
o <u>Satellite Instructional Television Experiment (SITE) 1975-1976</u>	1	NASA provided 4 hours per day of satellite time between August 1, 1975 and July 31, 1976, for use by the Indian Space Research Organization (ISRO) for broadcast of Indian-produced TV programs on family planning, health, and agricultural production directly to small, inexpensive, Indian-made ground receivers in some 2400 Indian villages.

## Cooperative Ground-Based Projects

Project	Number of Countries	Description
COMMUNICATION SATELLITE PROJECTS (Continued)		
ATS (Continued)		
ATS-6 May 1974-1979 (Continued)		
o S-Band Experiment 1975-1976	1	As an extension of NASA/SITE cooperation, ISRO demonstrated the feasibility of S-band for satellite community television transmission with receiver hardware similar to that being used in the SITE project and also improved understanding of propagation phenomena.
o Propagation Experiment at 13/18 GHz 1975-1976	2	ISRO and ESA experimenters operated NASA-supplied small ground transmit terminals at diverse sites with varied climatological conditions at 13 and 18 GHz to ATS-6 for relay back to an ESA-provided ground station at 4 GHz.
o Millimeter Wave Propagation Experiment 1975-1976	1	ESA experimenters participated in the ATS-6 experiment to evaluate the propagation characteristics of space-to-Earth links centered at 20 GHz and 30 GHz under measured meteorological conditions.
o Radio Beacon Experiment 1975-1976	1	The Indian Physical Research Laboratory (PRL) participated in the ATS-6 Radio Beacon Experiment with investigations of scintillation phenomena and measurements of total electron content by Faraday rotation technique and group delay method.
o SITE Solar Array Demonstration 1976	1	As an extension of SITE cooperation, ISRO conducted a test of the technical and economic feasibility of using solar cell arrays as power sources to operate standard SITE receiver terminals. NASA supplied the solar cell arrays.

## Cooperative Ground-Based Projects

Project	Number of Countries	Description
COMMUNICATION SATELLITE PROJECTS (Continued)		
ATS (Continued)		
ATS-6 May 1974-1979 (Continued)		
o Advanced Satellite for Interdisciplinary Communications, Brazil (SACI) 1975	1	NASA provided 30 minutes a day, 5 days a week of satellite time between February and May 1975 for use by INPE for the instruction of primary school students in the Brazilian state of Rio Grande de Norte.
o AID-sponsored International Applications Demonstration (AIDSAT) 1976	27	Agency for International Development (AID) and NASA used the ATS-6 experimental communications satellite to broadcast films and live discussions on remote sensing, communications, and disaster relief technologies and their applications for development to 27 developing countries from August through October 1976 as ATS-6 moved from geostationary position over Africa to the Western Hemisphere. The following countries participated in the demonstrations: Argentina, Bangladesh, Bolivia, Cameroon, Central African Empire, Costa Rica, Ecuador, Haiti, Ivory Coast, Jamaica, Jordan, Kenya, Libya, Mali, Mano River Union (Sierra Leone and Liberia) Morocco, Oman, Pakistan, Peru, Sudan, Suriname, Thailand, United Arab Emirates, Upper Volta, Uruguay, and North Yemen.
o Test of Portable Ground Terminals 1975-1978	1	Field test by GSFC of portable, low-cost experimental 12 GHz ground terminals supplied by the Japanese RRL with the CTS experimental communications spacecraft.
o Data Collection Platform Test 1977	2	In 1977, the Argentine National Space Commission and Bolivian Geological Service utilized the experimental Data Collection System (DCS) onboard Landsat-2 to determine the usefulness of communications satellites to relay data on river water levels, rainfall, and other phenomena occurring in remote locations to a central collection point. The cooperating agencies utilized portable transmitters in remote locations to send signals a central monitoring station several times a day as Landsat-2 passed within view.

## Cooperative Ground-Based Projects

Project	Number of Countries	Description
COMMUNICATION SATELLITE PROJECTS (Continued)		
o Communications Technology Satellite (CTS) Jan. 1976 - Nov. 1979	2	Communication and broadcasting satellite transmitting in 12 GHz band at high power levels to small terminals. Satellite time shared by US and Canada for broadcasting.
o Experimental Satellite System for Search and Rescue of Vessels and Aircraft in Distress 1982		US and USSR satellites equipped with transponders are to receive distress signals and relay them to ground stations for independent search and rescue operations during a demonstration test of the system beginning in 1982. This will be a joint experimental project between the Soviet system (COSPAS) and US/Canada/France system (SARSAT). In SARSAT, the Canadian Department of Communications (DOC) is providing spacecraft repeaters, and the French Centre National d'Etudes Spatiales (CNES) is providing spacecraft on-board receiver/processors. NASA, DOC and CNES are each supplying ground local user terminals and conducting demonstration activities in their respective countries. Additional countries may participate through investigators supporting project objectives, compatible technically and involving significant search and rescue user agency participation.
METEOROLOGICAL SATELLITE PROJECTS		
o TIROS 1961-1965	42	NASA/National Oceanic and Atmospheric Administration (NOAA) and 42 national weather services compared simultaneously acquired TIROS satellite photography and ground observations. These weather services were located in Argentina, Australia, Austria, Belgium, Brazil, Burma, Canada, Chad, Colombia, Costa Rica, Czechoslovakia, Denmark, El Salvador, France, Germany, Hong Kong, Hungary, Iceland, India, Indonesia, Iraq, Ireland, Jamaica, Japan, Kenya, Mauritius, Mozambique, the Netherlands, New Zealand, Norway, Poland, Portugal, Rhodesia, Senegal, Singapore, South Africa, Sudan, Switzerland, Thailand, United Arab Emirates, and UK.
• Automatic Picture (APT) 1963-present	116*	Nationally owned and operated APT direct receiving stations permit repeated readout of local cloud cover images from NOAA satellites.

\*See Appendix C for locations of APT stations.

## Cooperative Ground-Based Projects

Project	Number of Countries	Description
METEOROLOGICAL SATELLITE PROJECTS (Continued)		
o National Commission on Outer Space (CONEE) <u>1968</u>	1	Joint project combining satellite meteorological data acquired with NASA-loaned APT set with meteorological data from conventional sources to make effective communications network for disseminating data to users. Project led to 1972 joint United Nations (UN)/World Meteorological Organization (WMO) panel and training seminar on the use of meteorological satellite data held in Mexico City.
o Nimbus-4, Interrogation Recording and Location System (IRLS) <u>1971</u>	1	UK Institute of Aviation Medicine used Nimbus-4 IRLS for navigation and data relay purposes in round-the-world light aircraft flight in May 1971.
o French Eole Follow-On <u>1972</u>	1	After completion of the initial cooperative Eole satellite/balloon experiment, some of the remaining Eole electronic packages were installed on buoys for oceanographic experiments including a cooperative French/NASA/NOAA experiment to investigate the structure and relation of currents in the Western Atlantic and the Gulf Stream and others were placed on icebergs to study the continental current near Antarctica.
● Nimbus-6, RAMS <u>1974-present</u>	7	Investigators in Australia, Canada, Denmark, France, Norway, South Africa, and the UK are using or have used the Random Access Measurement System (RAMS) in meteorological and oceanographic experiments.
● Nimbus-7 <u>1977-present</u>	9	Scientists from the CEC, UK, Denmark, Switzerland, Canada, South Africa, Germany, France, and Belgium were selected by NASA in 1977 to participate in NASA-sponsored experiment teams to validate and conduct initial data-use investigations with data from the eight Nimbus-7 instruments.
● Nimbus-7 Direct Reception <u>1978-present</u>	1	In support of European members of the Nimbus-7 Experiment Teams, ESA is receiving Nimbus-7 Coastal Zone Color Scanner and Scanning Multifrequency Microwave Radiometer data directly at a ground station in Lannion, France.
● Cloud Height Study 1 Project <u>1979-81</u>	1	Measurements of cloud height by satellite stereography, using coordinated data obtained from SMS/GOES and Japan's Geosynchronous Meteorological Satellite (GMS) operated by Japan Meteorological Agency (JMA).

## Cooperative Ground-Based Projects

Project	Number of Countries	Description
<b>GEODYNAMICS</b>		
<ul style="list-style-type: none"> <li>o GEOS-1, Nov. 1965</li> <li>o PAGEOS, Jun. 1966</li> <li>o GEOS-2, Jan. 1968</li> </ul>	13.	<p>GEOS-1 (Explorer-29) and GEOS-2 (Explorer-36), active satellites containing instruments for optical and electronic observations, and PAGEOS, a passive reflector satellite for large-scale optical observations, were designed for a world-wide geodetic program to determine more accurately the Earth's size and shape. Twenty-seven non-US stations in Australia, Brazil, Chad, Chile, Ethiopia, Italy, Japan, Mauritius, Mexico, Netherlands, New Zealand, Norway, and UK have observed these satellites photographically to improve geodetic datum accuracies. France participated with NASA in the analysis of data obtained by the laser tracking of French and US geodetic satellites.</p>
<ul style="list-style-type: none"> <li>o National Geodetic Satellite Program (NGSP) 1966-1970</li> </ul>	23	<p>Argentina, Australia, Brazil, Chad, Chile, Denmark, Ecuador, Ethiopia, Germany, Iran, Italy, Japan, Mauritius, Mexico, New Zealand, Norway, Philippines, Portugal, Senegal, South Africa, Suriname, Thailand and UK accommodated BC-4 camera teams at 34 locations for US observations of PAGEOS. Program final report (NASA SP-365) published 1977.</p>
<ul style="list-style-type: none"> <li>o International Satellite Geodesy Experiment (ISAGEX) 1964-1972</li> <li>French Satellites: <ul style="list-style-type: none"> <li>Diademe-C</li> <li>Diademe-D</li> <li>PEOLE</li> </ul> </li> <li>US Satellites: <ul style="list-style-type: none"> <li>BE-B (Explorer-22)</li> <li>BE-C (Explorer-27)</li> <li>GEOS-1</li> <li>GEOS-2</li> </ul> </li> </ul>	24	<p>NASA cooperated in this Committee on Space Research (COSPAR)-initiated program for laser and optical observation of three French and four US satellites. These observations were completed in mid-1971 and involved Australia, Belgium, Brazil, Bulgaria, Czechoslovakia, Ethiopia, Finland, France, Germany-FRG, Germany-GDR, Greece, Hungary, India, Japan, the Netherlands, New Zealand, Peru, Romania, South Africa, Sweden, Switzerland, Spain, UK, and Union of Soviet Socialist Republics (USSR).</p>
<ul style="list-style-type: none"> <li>o GEOS-3, Apr. 1975-1979</li> </ul>	5	<p>Twelve investigators from Australia, Canada, France, Germany, and Israel conducted experiments in Earth physics, sea state, and ocean physics utilizing GEOS-3 doppler, laser, and C-band tracking and altimetry data.</p>
<ul style="list-style-type: none"> <li>o Lunar Laser Ranging Experiment (LURE) 1974-1976</li> </ul>	2	<p>Australian and French scientists ranged the laser retro reflectors left on the Moon's Mare Tranquillitatis, Fra Mauro, and Hadley Rim during the Apollo missions. The laser ranging yielded information on the motions of the Earth and the Moon.</p>

## Cooperative Ground-Based Projects

Project	Number of Countries	Description
GEODYNAMICS (Continued)		
• French Satellite STARLETTE Nov. 1977 - present	1	NASA and the French National Center for Space Studies (CNES) have agreed to exchange laser ranging observations of STARLETTE acquired by US and French laser stations.
o International Clock Synchronization Demonstration 1978 1979	6	Experimenters from Australia, Canada, Germany, France, Japan, and the UK participated with 4 US agencies in a clock synchronization demonstration using a NASA-developed receiver with the US Navigation Technology Satellites to compare worldwide clocks to an accuracy of approximately one msec. The Canadian and French experimenters used receivers on loan from NASA. Under a separate agreement, Brazil and US conducted a similar demonstration in 1979; Brazil used a receiver on loan from NASA.
• Laser Geodynamic Satellite (LAGEOS) July 1979 - present	4	Seven investigators from France, Germany, the Netherlands and the United Kingdom are conducting experiments in solid earth tides, precise position location, and orbital ephemeris using laser ranging data acquired with United States and European systems.
• Crustal Dynamics Project Feb. 1980 - present	3	Agreement concluded in July 1979 for NASA to assist VLBI development in Japan and for joint experiments to be initiated in 1983. A NASA mobile satellite laser ranging station in Western Australia and NASA/SAO laser and lunar laser in Eastern Australia support the crustal dynamics program. SAO lasers in Peru and Brazil, operated by SAO, also support this program.
• Applications Explorer Mission-C (Magnetic Field Satellite-Magsat) 1979 - present	8	Data use investigations were selected from Australia, Brazil, Canada, France, India, Italy, Japan, and the United States for a total of 34 investigations. These investigations utilize Magsat scalar magnetometer and vector magnetometer data to conduct studies in four categories -- geophysics, geology, field modeling and magnetosphere/ionosphere and core/mantle research. The satellite ceased operation in June 1980. Data analysis and research are continuing.

## Cooperative Ground-Based Projects

Project	Number of Countries	Description
SPACE PLASMA PROJECTS		
<ul style="list-style-type: none"> <li>o Alouette-1, Sep. 1962</li> <li>o Explorer-20, Aug. 1964</li> <li>o Alouette-2, Nov. 1965</li> <li>o ISIS-1, Jan. 1969</li> <li>o ISIS-2, Mar. 1971</li> </ul>	8	The Alouette/ISIS series of satellites used a swept frequency sounder system and Explorer-20 used a fixed frequency system to measure the ionospheric electron density. US and foreign stations take coordinated ground soundings and satellite top-side soundings which permit comparison of top and bottom-side ionospheric profiles. Australia, Canada, France, India, Japan, New Zealand, Norway, and the UK have operated stations for acquisition of top-side sounder data.
<ul style="list-style-type: none"> <li>o Explorer-22, Oct. 1964</li> <li>o Explorer-27, Apr. 1965 (Beacon Satellites)</li> </ul>	37	At 102 ground stations in Argentina, Australia, Austria, Belgium, Brazil, Canada, Chile, Denmark, Ethiopia, Finland, France, Germany, Ghana, Greece, India, Israel, Italy, Jamaica, Japan, Kenya, South Korea, Malaysia, New Zealand, Nigeria, Norway, Pakistan, Peru, Singapore, South Africa, Spain, Sudan, Sweden, Switzerland, Tanzania, Thailand, Turkey, and UK, plus Antarctica and Hong Kong, Faraday rotation, scintillation, and doppler differential experiments have been conducted in order to measure integrated electron density in a vertical plane between a satellite and the ground and variations in electron density as a function of latitude, season, and diurnal time.
o Orbiting Geophysical Observatory (OGO-6), Jan. 1969	1	Very low frequency (VLF) experiment reactivated in October 1971 to permit a 6-month Japanese study of VLF whistlers and emissions.
o Origin of Plasma in the Earth's Neighborhood (OPEN), 1978-1980	4	Scientists from Max Planck Institute (MPI), Garching, Germany; University of Bern, Switzerland; National Research Council of Canada (NRCC), Canada; and the University of Tokyo, Japan, participated in completion of program definition.
o EXOS-B/Siple Project Jul. 15-Sep. 7, 1980	1	Institute of Space and Aeronautical Science (ISAS) of the University of Tokyo observed effect of VLF signals transmitted by Stanford University's Siple transmitter in Antarctica with the ISAS EXOS-B satellite for study of wave-particle interaction in magnetospheric plasma.

## Cooperative Ground-Based Projects

Project	Number of Countries	Description
ATMOSPHERIC STUDY PROJECTS		
o Upper Atmosphere Particle Studies <u>1967</u>	1	The Swedish Space Research Committee (SSRC) and NASA arranged in 1967 for a mobile pulsed laser radar, located in Sweden, to be used to determine height, distribution, and scattering properties of cosmic dust and aerosol particles during the presence and absence of noctilucent clouds.
o Global Climatology of the Stratosphere, <u>1976</u>	1	NASA, GSFC, NOAA, and the Free University of Berlin jointly studied global climatology of the stratosphere using ozone data from Nimbus-4 backscattered ultraviolet (UV) experiment incorporating German analysis of stratospheric height and temperature fields.
• Atmospheric Explorer (AE) Program <u>1977-80</u> (UK) <u>1979-present</u> (Germany) <u>1981</u> (UK)	2	A scientist from Appleton Laboratory, UK. Used AE data in correlation with ground data Observatory in Puerto Rico for study of ion-drift and ion-drag phenomena. A scientist from the University of Bonn, Germany is using AE data to construct a statistical model of the ionosphere in the 60-4000 km region. In addition, scientists from the University of Freiburg, Germany and the Mullard Space Science Lab, UK will initiate studies using AE data in 1981.
o Correlative ground-based measurements to support Global Air Sampling Program (GASP) around-the-world flight, <u>1977</u>	4	NASA GASP instrument package to analyze ambient air by <u>in situ</u> sampling was carried by aircraft special flight around the world over the poles in Oct.-Nov. 1977. Scientists in Australia, New Zealand, South Africa, and the UK provided ground-based data for correlation with the airborne GASP data.
• Ground Truth Support of Applications Explorer Mission B/Stratospheric Aerosol and Gas Experiment (SAGE), launched in <u>1979</u>	3	One UK scientist is a member of the SAGE Experiment Team, assisting NASA in instrument development, prelaunch planning, and postlaunch sensor performance evaluation for the SAGE mission; experiment team members are currently engaged in SAGE data analysis activities. In addition, scientists from Belgium, Japan, UK, and the Joint Research Center (JRC) of the CEC are participating in ground truth science activities for SAGE and serving as members of the SAGE Ad Hoc Group Truth Working Group.
• Ground Ozone Instrument Intercomparison <u>1979-80</u>	2	Ground ozone measurement instruments provided by Canada, New Zealand, and the USSR have been operated with the Dobson spectrophotometer at NASA Wallops Flight Center for intercomparison and calibration purposes.

## Cooperative Ground-Based Projects

Project	Number of Countries	Description
ATMOSPHERIC STUDY PROJECTS (Continued)		
<ul style="list-style-type: none"> <li>International Ozone Intercomparison, 1979</li> </ul>	4	<p>Twenty sounding rocket flights were conducted at NASA Wallops Flight Center for an intercomparison of rocket-borne ozone sensors. Sensors were provided by Australia, Canada, India, and Japan, as well as several US organizations. NASA hosted the activity on behalf of its sponsors, the World Meteorological Organization (WMO) and the Federal Aviation Administration of the U.S. Department of Transportation.</p>
<ul style="list-style-type: none"> <li>Stratospheric Aerosol and Gas Experiment II (SAGE II) 1984</li> </ul>	3	<p>Investigators from France, Italy and Japan have been selected as members of the SAGE-II Experiment Team. They are assisting NASA in instrument development for SAGE II and will conduct correlative science support activities and initial data use investigations. The SAGE II instrument will be flown on the Earth Radiation Budget Satellite (ERBS), planned for launch in 1984.</p>
<ul style="list-style-type: none"> <li>Earth Radiation Budget Experiment (ERBE) 1984</li> </ul>	3	<p>Two investigators from France and one each from Germany and the UK are members of the ERBE Experiment Team. They are assisting in ERBE instrument development and will conduct initial data use investigations. The ERBE instrument will be flown on the Earth Radiation Budget Satellite (ERBS), planned for launch in 1984 and also on two NOAA operational environmental satellites projected for launch before and after ERBS.</p>
<ul style="list-style-type: none"> <li>Halogen Occultation Experiment (HALOE) 1984</li> </ul>	2	<p>Two UK investigators and one Canadian are serving as members of the HALOE Experiment Team. They will assist NASA in HALOE instrument development and will conduct correlative measurements activities and initial data HALOE instrument is planned for flight on scheduled for launch in 1984.</p>
<ul style="list-style-type: none"> <li>Upper Atmosphere Research Satellites (UARS) 1981</li> </ul>	2	<p>Investigators from France and the UK have been selected as member's of the UARS Instrument Defunction Phase Study Team which will extend over a period of 10 months and consist of detailed instrument defunction, conceptual design and program defunction.</p>

## Cooperative Ground-Based Projects

Project	Number of Countries	Description
SUPPORT OF MANNED SPACE FLIGHTS		
<ul style="list-style-type: none"> <li>• Lunar Sample Studies (Apollo Missions) 1969-present</li> </ul>	21	More than 90 foreign Principal Investigators (PI's) and more than 280 foreign Co-Investigators (Co-I's), from Australia, Belgium, Brazil, Canada, Czechoslovakia, ESA, Finland, France, Germany, India, Italy, Japan, Korea, Mexico, Norway, China (Taiwan), South Africa, Spain, Switzerland, USSR, and UK, are, or have been, conducting a full range of experiments on samples of lunar rocks and fine materials returned by the Apollo Lunar Landing Missions. Studies involve mineralogy and petrology, chemical and isotopic analyses, physical properties, and bioscience and organic analyses.
<ul style="list-style-type: none"> <li>o Biomedical Experiments Team Skylab 1973-1975</li> </ul>	2	German Air Force and UK Royal Air Force physicians and life scientists were assigned for two years to NASA Johnson Space Center (JSC) as part of the Skylab biomedical team studying effects of long duration space flight on crew.
SUPPORT OF PLANETARY FLIGHTS		
<ul style="list-style-type: none"> <li>o Planetary Surface Feature Studies 1973-1976</li> </ul>	1	MPI, Heidelberg/University of Tuebingen/University of Munich (Germany). Digital and photographic image processing. Production of planetary lineament maps using data provided by NASA.
<ul style="list-style-type: none"> <li>o Measurement of Radio Emissions from Jupiter, 1976</li> </ul>	1	Meudon Observatory (France) operated NASA-provided electronic equipment and antennas at the Nancy Radioastronomy Station as part of the NASA network monitoring decimeter wavelength radio emissions from Jupiter.
<ul style="list-style-type: none"> <li>o Planetary Geology Program 1976</li> </ul>	1	The Laboratory of Dynamic Internal Geology of the University of Paris-Sud (France) conducted structural study of scarps visible on surface of Mercury and compared the structures on Mercury with structures on the Moon and Earth.
<ul style="list-style-type: none"> <li>• Planetary Geology Program 1977-present</li> </ul>	1	University of Munich Institute for General and Applied Geology and MPI, Heidelberg (Germany) are carrying out monoscopic and stereoscopic measurements of planetary images and preparation of topographic and lineation maps.
<ul style="list-style-type: none"> <li>o Viking Guest Investigator Program 1976-1979</li> </ul>	4	Scientists from the University of Munich, Germany/Rene Bernas Laboratory, France/University of Melbourne, Australia/SRC, UK/and CNES, France, are participating in studies using data from the NASA Viking Mars Mission.

## Cooperative Ground-Based Projects

Project	Number of Countries	Description
SUPPORT OF PLANETARY FLIGHTS (Continued)		
<ul style="list-style-type: none"> <li>• Saturn Orbiter Study Project 1979-1981</li> </ul>	1	Coordinated study by Institute of Space and Aeronautical Science (ISAS) of the University of Tokyo of pre-entry science modules for Saturn and Titan entry probes for a possible Saturn Orbiter Dual Probe mission in the late 1980's.
ASTRONOMY AND ASTROPHYSICS		
<ul style="list-style-type: none"> <li>• Orbiting Astronomical Observatory-3 (OAO-3) Guest Investigator Program 1972-1981</li> </ul>	13	<p>Fifty-three astronomers from the following institutes have carried out observing programs on OAO-3, commonly referred to as "Copernicus":</p> <p>Australia: Anglo-Australia Observatory  Austria: University of Vienna  Belgium: Institute of Astrophysics, University of Liege, and Brussels University  Canada: The University of Western Ontario, University of Alberta, University of Montreal,  David Dunlap Observatory and Dominion Astrophysical Observatory  ESA: Headquarters  Finland: University of Helsinki  France: CNRS, Center for Nuclear Studies (CENS), Astrophysics Institute, and Paris Observatory  Germany: University of Bonn; MPI, Garching; and Bamberg Observatory  Italy: Observatory of Trieste, University of Padua  Netherlands: Kapteyn Astronomical Observatory, The University of Utrecht, University of Groningen, and University of Amsterdam  Poland: University of Wroclaw and Institute of Astronomy at Warsaw  South Africa: South African Astronomical Observatory  USSR: Crimean Astrophysical Observatory and Byurakan Observatory (Armenian SSR)  UK: Culham Laboratory; Queen's University, Belfast; Oxford University; and University College, London</p>
<ul style="list-style-type: none"> <li>• Machine Readable Star Catalogues 1978-1981</li> </ul>	1	The Center for Stellar Data (CDS) of Strasbourg, France, and NASA are coordinating their activities in the area of machine readable star catalogues. (Seven European institutes participate in CDS.)

## Cooperative Ground-Based Projects

Project	Number of Countries	Description
ASTRONOMY AND ASTROPHYSICS (Continued)		
• Monograph Series on Stellar Astrophysics 1978-1981	1	The French CNRS and NASA are jointly sponsoring a series of monographs on the subject of Stellar Astrophysics.
• Small Astronomy Satellite-3 (SAS-3) Guest Investigator Program 1978-1981	4	Scientists from the Tata Institute of Fundamental Research (TIFR), India; University of Tasmania, Australia; the Dominion Astrophysics Laboratory and McMaster University, Canada; and Cambridge University, UK are carrying out studies using SAS-3 data.
• Advanced X-Ray Astrophysics Facility (AXAF) 1978-1981	2	Scientists from the University of Leicester, UK and MPI, Garching, Germany are participating in the NASA AXAF feasibility study.
• High Energy Astronomical Observatory-1 (HEAO-1) Guest Investigator Program 1977-1981	4	Scientists from National Center for Scientific Research (CNRS) and CNES, France; Radio Astronomy Group, Switzerland; University of Calgary, Canada; and University of Tel Aviv, Israel have conducted or are conducting studies using data from HEAO-1.
• HEAO-2 Guest Investigator Program 1978-1981	16	Over eight scientists from the following institutes have carried out observing programs on HEAO-2, commonly referred to as the "Einstein Observatory":  Australia: Anglo-Australian Observatory, Australian National University, Commonwealth Scientific and Industrial Research Organization, and University of Tasmania. Brazil: Brazilian Astrophysical Observatory Canada: Dominion Astrophysical Observatory, Queens University, University of British Columbia, University of Calgary, University of Montreal, University of Toronto and University of Victoria. France: CENS, CNES, Paris Observatory and Meudon Observatory. Germany: MPI, Bonn, Bonn University and the European Southern Observatory, Munich. Greece: University of Ioannina India: TIFR

## Cooperative Ground-Based Projects

Project	Number of Countries	Description
ASTRONOMY AND ASTROPHYSICS (Continued)		
HEAO-2 (Continued)		<p>Italy: Astronomical Observatories at Padova, Palermo, Trieste and Catania; University of Padova and the National Research Council.</p> <p>Japan: University of Tokyo.</p> <p>Mexico: University of Mexico</p> <p>Netherlands: University of Leiden, Kapteyn Observatory, Leiden Observatory, Sonnenborgh Observatory, Netherlands Foundation for Radioastronomy.</p> <p>Poland: Warsaw University</p> <p>Sweden: Stockholm University</p> <p>Switzerland: European Southern Observatory, Geneva.</p> <p>United Kingdom: Institute of Astronomy, University of Cambridge, Royal Greenwich Observatory</p> <p>USSR: Academy of Sciences and Sternberg Astronomical Institute.</p>
o Solar Maximum Mission (SMM) Guest Investigator Program 1980-present	13	<p>Astronomers from the following institutes are carrying out Guest Investigator Programs using data from SMM:</p> <p>Argentina: National Commission for Space Research</p> <p>Australia: University of Sydney.</p> <p>Belgium: University of Mons.</p> <p>Brazil: National Observatory.</p> <p>France: Toulouse Observatory, Meudon Observatory.</p> <p>Germany: University of Bonn, Kiepenheuer Institute</p> <p>India: Udaipur Solar Observatory.</p> <p>Ireland: Queen's University, Saint Patrick's College</p> <p>Italy: University of Torino, Arcetri Astrophysical Observatory.</p> <p>Japan: Tokyo Astronomical Observatory</p> <p>Sweden: Stockholm Observatory</p>

## Cooperative Ground-Based Projects

Project	Number of Countries	Description
ASTRONOMY AND ASTROPHYSICS (Continued)		
SMM (Continued)		<p>Switzerland: Radio Astronomy Group</p> <p>UK: University of Cambridge, University of Bristol, Culham Laboratory, University College London, University of Glasgow, Saint Andrews University.</p>
<ul style="list-style-type: none"> <li>SMM/Astro-A Collaborative Observations Program 1980-81</li> </ul>	1	Coordinated observations and data analysis of solar flares using SMM and the Institute of Space and Aeronautical Science (ISAS) of the University of Tokyo Astro-A spacecraft data.

## Cooperative Balloon and Airborne Projects

Project	Number of Countries	Description
BALLOON FLIGHTS:		
o <u>Spectro-telescope Studies 1966-1973</u>	1	The Institute for Space Physics Research (IPW) of Freiburg, Germany and NASA conducted three high altitude balloon soundings using a high resolution solar spectro-telescope designed to gain new knowledge of fine structure elements of solar atmosphere. NASA provided balloons that carried the instruments to an altitude of about 24,386 m (80,000 ft). Flights were conducted in Nov. 1966, Nov. 1968 and in 1973. The United States (US) National Center for Atmospheric Research (NCAR) provided launching services from the Balloon Flight Station, Palestine, Texas.
o <u>Study of Stellar Near Ultraviolet Light 1968</u>	1	Under an agreement between the Swiss Committee for Space Research (SCSR) and NASA, a balloon flight was made in Sep. 1968 from the NCAR facility at Palestine, Texas. The balloon payload, developed by the Observatory of Geneva, was designed to study stellar near ultraviolet (UV) radiation. The balloon lifted the 170-kg (375-lb) payload to an altitude of about 41,450 m (136,000 ft).
o <u>Study of Solar and Atmospheric Neutrons 1969-1972</u>	1	Max Planck Institute (MPI), Munich and NASA conducted a series of high altitude balloon soundings to measure the flux of neutrons of solar origin. NASA provided balloons carrying large (over 590-kg (1300 lb)) German payloads to altitudes of over 30,480 m (100,000 ft). Instrumentation consisted of large spark chambers in which scattering events can be recorded. Flights were conducted in Sep. 1969 and Oct. 1972.
o <u>Stratospheric Studies, 1977</u>	1	Under an agreement between the Canadian Atmospheric Environment Service (AES) and NASA, a joint balloon flight project was conducted in Nov. 1977 from the National Scientific Facility, Palestine, Texas, for (1) an intercomparison of different techniques for measurements of stratospheric gases. Two US balloons were launched, one carrying US instrumentation and the other Canadian.

o Completed Project  
 ● Current

## Cooperative Balloon and Airborne Projects

Project	Number of Countries	Description
BALLOON FLIGHTS: (Continued)		
o Stellar Ultraviolet (UV) Astronomy Studies 1976	2	The Space Research Laboratory (SRL) at Utrecht, the Netherlands, Liege University, Belgium, and NASA carried out a series of launchings of the Balloon Borne Ultraviolet Spectrophotometer (BUSS) instrument from the NCAR facility at Palestine, Texas for high resolution UV spectrometry of main sequence stars. The 726-kg (1600-lb) BUSS instrument was floated at an altitude of about 38,100 m (125,000 ft) for up to 12 hours, enabling detailed spectrographic studies.
• Stratospheric Research Nimbus-7 Limb Infrared Monitor of the Stratosphere (LIMS) Data Validation 1978 1979 1980	5	Experimenters from Belgium, Canada, Germany, France, and the United Kingdom (UK) provided instruments for joint balloon flights as part of the LIMS data validation effort. In addition, a UK experimenter is performing ozone measurements from the Argentine Islands in the Antarctic using NASA-supplied ozonesondes and balloons.
• Trans Pacific Ballooning Study 1980-81	1	Joint study with Institute of Space and Aeronautical Science (ISAS) of the University of Tokyo of Meteorological feasibility of a program of large-sized Trans Pacific balloons for cosmic and gamma ray measurements.
o Stratospheric Studies 1980	1	Under a NASA/AES agreement, a Canadian balloon-borne stratosphere measurement experiment and a NASA balloon-borne LIDAR system were flown from the NCAR facility at Palestine, Texas in October 1980 to obtain simultaneous observations of stratospheric constituents using different measurement techniques.
AIRBORNE OBSERVATIONS:		
o Solar Eclipse Observation Flights South Pacific, May 1965 Brazil, Nov. 1966	4	Experimenters from Belgium, Italy, the Netherlands, and Switzerland joined US scientists in May 1965, and experimenters from Italy joined in November 1966, in studying the structure and composition of the solar atmosphere, searching for faint comets in the vicinity of the Sun, and conducting temperature distribution studies.

## Cooperative Balloon and Airborne Projects

Project	Number of Countries	Description
AIRBORNE OBSERVATIONS: (Continued)		
o Auroral Expeditions Convair 990 Polar Region Flights Feb.-Mar. 1968 Nov.-Dec. 1969	4	Two groups of experimenters from Canada, one from France, and observers from Norway and Sweden joined US experimenters on a series of flights from Churchill Research Range, Canada, principally to look for aurorae at midday in a region where the Sun remains below the horizon throughout the day.
o Astronomical Mirror Loan Dec. 1971-May 1972	1	On loan to CNES/Paris Observatory is a NASA CV-990 gyro-stabilized mirror system for infrared (IR) astronomy onboard a French Mystere aircraft.
o Infrared (IR) Astronomy, 1974	1	Two experiments proposed by the Meudon Observatory were conducted on the NASA Airborne Infrared Observatory (AIRO): One to obtain spectral measurements of the far IR spectrum of Jupiter and the other to study the emission lines from interstellar matter.
o Comet Kohoutek Observation on Airborne Science Spacelab Experiments System Simulation (ASSESS I) Flight, 1974	3	Experimenters from France, Germany and Italy joined US scientists in infrared and ultraviolet observations of Comet Kohoutek during the first ASSESS mission.
o ASSESS I Convair 990 Flights from Moffett Field, California, May 1975	1	Candidate Spacelab science and applications instruments sponsored by the European Space Agency (ESA) and NASA were flown on the NASA CV-990 Airborne Laboratory to simulate a Spacelab mission.
o Meteors-Observation of Quarahtid Meteor Shower Near Ottawa, Canada, 1976	1	Experiments from Canada conducted complementary observations using high and low power meteor radars in the Ottawa area and batteries of ground spectrographs at two stations.
o Cloud Motion Wind Estimates NASA P-3 Aircraft, Flights in Bermuda Area, Jan.-Feb. 1976	1	A French experimenter participated in Phase IV "Wind Estimate from Cloud Motion" Aircraft Experiment to verify geostationary satellite-derived cloud motion wind estimates. Data on cloud height and cloud motion acquired from the aircraft were compared with cloud motion wind estimates derived from Synchronous Meteorological Satellite (SMS)/GEOS-1 satellite cloud height and cloud motion data acquired over the same area in the same time period. This verification project supported preparation for First GARP (Global Atmospheric Research Program) Global Experiment (FGGE).

## Cooperative Balloon and Airborne Projects

Project	Number of Countries	Description
AIRBORNE OBSERVATIONS: (Continued)		
o Stratospheric Latitude Survey Convair 990 Flights from Alaska to New Zealand, Nov. 1976	3	French infrared absorption grille spectrometer included as part of aircraft instrument complement to investigate composition of upper atmosphere, particularly type and density of trace constituents, and to determine whether concentration of trace constituents differs between Northern and Southern Hemispheres. Experimenters in Australia and New Zealand conducted coordinated complementary ground-based measurements including radiosonde vertical temperature profiles and ozonesonde and Dobson spectrophotometer measurements of ozone.
o Infrared Stellar Observations o 1976 o 1978 • 1979-1981	4	Stockholm Observatory in Sweden in furnishing flight and test hardware for NASA Lear Jet observation flights to study the infrared spectra of K and M stars.  The Meudon Observatory is furnishing interferometric and associated equipment to study ionic abundances, electron density, and ionization and velocity structure of selected stellar objects. This work is done on the NASA Kuiper Airborne Observatory (C-141).
o Cloud Motion Wind Estimates Convair 990 Flights from Moffett Field, California, Feb.-May 1977	1	ESA and the Astronomical Institute, University of Utrecht, the Netherlands, are furnishing a super heterodyne submillimeter-wavelength spectrometer to investigate the transitions which occur in the formation of collapsing interstellar clouds. This work is done on the NASA Kuiper Airborne Observatory (C-141).  French high resolution multispectral scanning radiometer "Aries" included among instruments on board aircraft for Phase V of "Wind Estimate from Cloud Motion" program. French radiometer experiment will simulate response of proposed satellite sensors to middle and high-level clouds over a mid-latitude oceanic region, with a view to measurement of cloud height using a visible channel and various infrared channels.
o ASSESS II (Flown in US and Europe) May 1977	1	European scientific instruments sponsored by ESA and NASA applications experiments were flown on the NASA CV-990 research aircraft in the second simulation of nine-day SpaceLab mission.

## Cooperative Balloon and Airborne Projects

Project	Number of Countries	Description
AIRBORNE OBSERVATIONS: (Continued)		
o Stratospheric Studies 1977 <u>1979</u>	1	Under agreements between AES and NASA, US and Canadian experimenters participated in coordinated flights of the NASA U-2 aircraft and Canadian balloons from Cold Lake, Alberta to investigate the observed decrease of nitrogen dioxide (NO <sub>2</sub> ) north of 45° N latitude.
o Solar Eclipse Studies <u>1979-80</u>	1	A solar telescope experiment developed by the University of Calgary in Canada was flown on the NASA Lear Jet during the February 1979 solar eclipse to observe the extreme limb of the sun in the far infrared. The same experiment was flown on the NASA CV 990 in the vicinity of Panama during the annular eclipse in August 1980.
o Airborne LIDAR Observations <u>1980</u>	1	Under a NASA-CNES agreement, a CNRS wavelength control device was inserted in the NASA Airborne Differential Absorption LIDAR (DIAL) System. The system was flown on the NASA Electra aircraft from NASA Wallops Flight Center (WFC) in November 1980 to obtain measurements of water vapor.
• Airborne Synthetic Aperture Radar Observations of Geological Sites, <u>1980-1981</u>	1	A JPL L-band Synthetic Aperture Radar (SAR) System will be mounted on a French Groupement pour le Développement de la Teledetection Aerospatiale (GDIA) aircraft for flight over a number of test sites, principally in Equatorial Africa, at the time of the planned Shuttle flight SS-3 in 1980-81. The NASA Spaceborne Imaging Radar-A (SIR-A) on board the Shuttle would also take data over the sites. The objective is to assess SAR capabilities to obtain geologically significant information on a variety of areas under varied conditions.
<ul style="list-style-type: none"> <li>o Completed Project</li> <li>• Current</li> </ul>		

## Cooperative Aeronautical Projects

Country, Project, and Date	Description
<b>CANADA</b>	
<ul style="list-style-type: none"> <li>• Augmentor-Wing Flight Test Project 1970-present</li> <li>• Vertical Take-Off and Landing (VTOL) Jet Augmentor Tests, 1974-present</li> </ul>	<p>The Canadian Department of Industry, Trade and Commerce and NASA are jointly funding a multiyear flight test project on a STOL (short take-off and landing) research aircraft incorporating the "Augmentor-Wing" concept.</p> <p>The Canadian Defence Research Board and NASA are conducting a jointly-funded research program on jet-augmentors for VTOL aircraft, involving small-scale wind-tunnel tests in Canada and large-scale wind-tunnel and static tests at NASA Ames Research Center (ARC).</p>
<b>FRANCE</b>	
<ul style="list-style-type: none"> <li>o Tilt Rotor Vertical/Short Take-Off and Landing (V/STOL) Tests 1969-1972</li> <li>o Transonic Wind Tunnel Flutter Tests 1972-1973</li> <li>o Wake Vortex Studies 1974</li> <li>• Propagation of Acoustic Disturbances 1976-present</li> <li>• Jet Noise 1976-present</li> <li>• Helicopter Blade Tip Aerodynamics 1979-present</li> </ul>	<p>National Office of Aerospace Studies and Research (ONERA) and NASA conducted a cooperative wind tunnel research program to test tilt rotors for V/STOL aircraft. Wind tunnels in the United States (US) and France were used in carrying out the project.</p> <p>ONERA and NASA began a research project on transonic flutter to improve confidence in transonic wind tunnel flutter results and flutter techniques used in NASA and ONERA wind tunnels.</p> <p>In cooperation with ONERA, a study was conducted to compare wake vortex turbulence behind typical subsonic and supersonic transports.</p> <p>A study was initiated with ONERA on propagation of acoustic disturbances through a shear layer for fixed and moving sources. The effort was extended in 1979 to include evaluation of the effects of forward motion on the radiation of noise from sources (e.g., jet exhausts) in close proximity to an aircraft fuselage.</p> <p>ONERA in cooperation with NASA is studying the effect of forward speed on jet noise by using wind tunnel measurements on the J-85 engine.</p> <p>ONERA and NASA are exchanging transonic tunnel data and calculations of blade vortex flow.</p>
<ul style="list-style-type: none"> <li>o Completed Project</li> <li>• Current</li> </ul>	

## Cooperative Aeronautical Projects

Country, Project, and Date	Description
FRANCE (Continued)	
<ul style="list-style-type: none"> <li>Research on Terminal Area Time-Based Descent Concepts <u>1980-present</u></li> </ul>	ONERA and NASA have agreed to conduct research utilizing the Langley TCV B737 cockpit and motion-based simulator to evaluate terminal area time-based descent concepts, computations, adequacy of information using both current flight instruments and advanced electronic displays, time accuracy at delivery points, and pilot acceptability.
GERMANY	
<ul style="list-style-type: none"> <li>o Dornier 31 V/STOL Flight Simulation and Flight Tests, <u>1969-1970</u></li> </ul>	Federal Ministry for Education and Science, Germany (BMBW) and NASA conducted two cooperative projects based on the advanced Jet V/STOL transport Dornier 31 (D0-31). In the first, NASA conducted flight simulation programs to study stability, control, and handling qualities during landing, transition, and descent phases of flight. In the second, NASA pilots flew the D0-31 for approximately 12 hours to test performance limitations under various V/STOL descent and ascent conditions.
<ul style="list-style-type: none"> <li>Helicopter Blade Tip Loading <u>1977-present</u></li> </ul>	This cooperative study of aerodynamic loads on the helicopter blade tips of varying designs is in collaboration with the German Aerospace Research and Test Establishment (DFVLR) Institute for Aeroelastics in Goettingen, Germany.
<ul style="list-style-type: none"> <li>Advanced Airfoil Research Program <u>1980-present</u></li> </ul>	A collaborative NASA/DFVLR research program is being undertaken to test CAST 10-2 and DFVLR R-4 Airfoils fabricated and furnished by DFVLR in the Langley 0.3-meter Transonic Cryogenic Tunnel. The experimental results will enable an evaluation (from low to high Reynolds numbers) of current DFVLR and NASA analytical techniques.

## Cooperative Aeronautical Projects

Country, Project, and Date	Description
NETHERLANDS	
<ul style="list-style-type: none"> <li>• <u>Transonic Airfoil Study</u> 1976-present</li> </ul>	A study of transonic unsteady aerodynamics of two-dimensional airfoils is continuing in cooperation with the National Aerospace Laboratory (NLR).
<ul style="list-style-type: none"> <li>o <u>Aircraft Fuel Saving Study</u> 1978-1980</li> </ul>	A study initiated in cooperation with the Netherlands Department of Civil Aviation was conducted to evaluate aircraft fuel savings by using real-time global meteorological data in flight planning. (The study has since been extended to include Canadian and United Kingdom participation.)
UNITED KINGDOM	
<ul style="list-style-type: none"> <li>o <u>Wind Tunnel and Flight Test Correlations</u> 1967-1970</li> </ul>	A study was conducted with the Ministry of Technology to correlate a boundary layer control flap system installed on a Hunting-126 aircraft using wind tunnel and flight test results.
<ul style="list-style-type: none"> <li>o <u>Runway Traction Study</u> 1968-1969</li> </ul>	A study was conducted in cooperation with the Ministry of Technology to test the effects of runway grooving on aircraft and ground vehicle performance and handling.
<ul style="list-style-type: none"> <li>• <u>Thrust Vectoring in Forward Flight</u> 1972-present</li> </ul>	This cooperative effort involved the Ministry of Defence (Procurement Executive)-Royal Aircraft Establishment (MOD(PE))-RAE in a study to determine the effects of thrust vectoring on aircraft performance and handling. Simulator and flight tests were conducted in both the US and United Kingdom (UK).
<ul style="list-style-type: none"> <li>• <u>Scale and Wind Tunnel Effects Study</u> 1974-present</li> </ul>	NASA and the MOD(PE)-RAE agreed to conduct tests on a UK-furnished model to assess scale effects and wind tunnel effects at transonic speeds.
<ul style="list-style-type: none"> <li>• <u>Atmospheric Turbulence Simulation</u> 1975-present</li> </ul>	NASA conducted, in cooperation with the MOD(PE)-RAE an evaluation of a Royal Aircraft Establishment turbulence model on a NASA flight simulator.
<ul style="list-style-type: none"> <li>• <u>Airfoil Tests in Cryogenic Wind Tunnels</u> 1975-present</li> </ul>	NASA and the MOD(PE)-RAE are involved in a program to determine the effects of Reynolds number and condensation on the pressure differential of a "Peakey" airfoil in a cryogenic wind tunnel.
NASA INTERNATIONAL PROGRAMS	

## Cooperative Aeronautical Projects

Country, Project, and Date	Description
UNITED KINGDOM (Continued)	
• Jet and Fan Noise Test Technique 1977-present	In cooperation with the MOD(PE)-RAE the results of UK-tested engine nozzles are being compared with the results of UK engine nozzles tested in NASA wind tunnels.
• Atmospheric Turbulence Simulation for Structural Loads 1979-present	NASA turbulence data obtained during B-57B flight tests is being used to validate a MOD(PE)-RAE method of predicting response to turbulence.
• Power Plant Installation Aerodynamics 1979-present	NASA and MOD(PE)-RAE are exchanging afterbody model transonic data and computations of aerodynamics.
• Aircraft Icing 1979-present	The MOD(PE)-RAE is using a NASA particulate sampling probe in UK flight tests to gain better understanding of icing formation.
• Power Plant Installation Aerodynamics 1979-present	NASA and Royal Aircraft Establishment are exchanging afterbody model transonic data and computations of aerodynamics.
• Aircraft Icing 1979-present	The Ministry of Defence (Procurement Executive) is using a NASA particulate sampling probe in UK flight tests to gain better understanding of icing formation.
• Flow Instabilities on a Thick Biconvex Airfoil 1980-present	NASA will compute flow field about biconvex airfoil at transonic speeds and provide MOD(PE)-RAE with results; MOD(PE)-RAE will provide NASA with results of transonic wind-tunnel tests on same airfoil and each organization will correlate the computational and experimental results.
• Computation of Two-Dimensional Airfoil Transonic Flow at High Reynolds Numbers 1980-present	NASA will provide MOD(PE)-RAE with Navier-Stokes Fortran Code for computing the flow over two-dimensional airfoils at transonic speeds and high Reynolds numbers with sufficient documentation for research; MOD(PE)-RAE will apply code to shock/boundary-layer interaction experiments and supply NASA with detailed results of comparisons and experimental data.

## Cooperative Aeronautical Projects

Country, Project, and Date	Description
<ul style="list-style-type: none"> <li>• Calculation of Transonic Flow Characteristics of Three-Dimensional Low-Aspect-Ratio Wings 1980-present</li> <li>• Active Control Technology/Handling Qualities--Advanced Control Systems 1980-present</li> <li>• Transonic Fighter Wing-Design Methods 1980-present</li> <li>• Vortex Phenomena at High Angles of Attack 1980-present</li> <li>• V/STOL Control System/Cockpit Display Trade-Offs 1980-present</li> </ul>	<p>NASA and MOD(PE)-RAE will each conduct wind tunnel tests of a different low aspect ratio wing design and exchange test results, as well as computations of the flow characteristics of the wing tested by each organization.</p> <p>MOD(PE)-RAE will provide NASA with results of theoretical work on design of advanced nonlinear control laws, simulation studies, and software specification (in compatible Fortran) of control laws in a form prescribed by NASA. NASA will conduct analyses of the advanced control concepts, implement Fortran control laws on the F-8 Remotely Augmented Vehicle facility, conduct flight research on the various algorithms, and provide the results to the MOD(PE)-RAE.</p> <p>NASA will provide MOD(PE)-RAE with wind tunnel data of its SMF-2 supercritical wing design and procedure for designing a surface to obtain a specified pressure distribution, and MOD(PE)-RAE will provide parallel data on its M-86 wing-body design. Each organization will make analytical calculations of the two wing designs, correlate the results with the experimental results and exchange the correlations. Based on the results, the design philosophy for transonic fighter wings will be discussed.</p> <p>(1) NASA will provide MOD(PE)-RAE with leading-edge suction analogy (LESA) computer code and MOD(PE)-RAE will provide NASA with wing-strake model design and test data on RAE model 2061. Each organization will use the LESA code to calculate the vortex flow for model 2061 and correlate the results with the experimental results.</p> <p>(2) MOD(PE)-RAE will provide NASA with analytical method for predicting laminar separation, vortex formation, and pressures for elliptic cones at high angles of attack and NASA will test an elliptic cone body in its 0.3-meter cryogenic tunnel. Each organization will calculate the body aerodynamics using RAE analytical method and correlate the results with the experimental results.</p> <p>NASA's pilot/engineers will participate in MOD(PE)-RAE V/STOL control and display research programs utilizing ground-based simulation and flight trials with Harrier XW-175. MOD(PE)-RAE pilots/engineers will participate in NASA's ground-based simulation programs of Harrier and lift-fan aircraft and in the proposed flight program on the YAV-88, if it is undertaken. Exchange of data will be limited to that directly associated with the pilot/engineer interchanges.</p>

## US/USSR Coordinated Space Projects

Project and Date	Description
oo 1962 Agreement:	
o	Established a communications link for exchange of meteorological data now handled by the State Committee of the Union of Soviet Socialist Republics (USSR) on Hydro-meteorology and Control of the Natural Environment and the National Oceanic and Atmospheric Administration (NOAA).
Telecommunication, <u>1962-1964</u>	Experiments using the United States (US) passive communications satellite Echo-2, antennas at the USSR Zemenki facilities.
Geomagnetic Mapping, <u>1962-1973</u>	Data were exchanged from ground-based observatories on Cosmos 49, Cosmos 321, Orbiting Geophysical Observatory (OGO)-2, and OGO-6.
o Joint Review of Space Biology and Medicine <u>1965-1976</u>	NASA SP-374: Foundations of Space Biology and Medicine completed in 1976 in both English and Russian. Three volumes of joint and independent papers on experience in space flight research in fields of biology and medicine.
o Apollo-Soyuz Test Project (ASTP), <u>1970-1975</u> October 1970 Agreement - Study Phase April 1972 Agreement - Developmental Phase May 1972 - Summit Agreement	Under the initial US/USSR agreement on compatible rendezvous and docking systems, both countries examined technical and feasibility aspects. In April 1972, the Soviet Academy and NASA decided to commence development and plan for a test flight in 1975. The May 1972 Summit Agreement confirmed that and other bilateral undertakings in US/USSR space cooperation. In July 1975 the Apollo and Soyuz crafts docked successfully, and each crew visited the other's spacecraft and conducted five joint experiments.
• 1971 Agreement on Space Sciences and Applications - Renewed in <u>1974</u> and <u>1977</u>	Building on earlier experience, this agreement provides for: Exchange of lunar samples; exchange of information regarding results of space research; exchange of findings of interest from planetary probes; coordination of meridional meteorological sounding rocket networks; coordinated studies of ocean and vegetation surveys in agreed areas by space and conventional means; exchange of biomedical results in manned space flights; flight of US life sciences experiments of Soviet biosatellites; and flight of USSR life sciences experiments on Spacelab.

- o Completed Project
- Current

## US/USSR Coordinated Space Projects

Project and Date	Description
<ul style="list-style-type: none"> <li>Experimental Satellite System for Search and Rescue of Vessels and Aircraft in Distress, May 1977, US-USSR Protocol. (US/USSR/Canada/France) Understanding signed November 1979--entered into force August 13, 1980</li> </ul>	<p>US and USSR satellites equipped with transponders are to receive distress signals and relay them to ground stations for independent search and rescue operations during a demonstration test of the system beginning in 1982. This will be a joint experimental project between the Soviet system (COSPAS) and a US/Canada/France system (SARSAT).</p>
<ul style="list-style-type: none"> <li>Manned Space Flight, 1977-present May 1, 1977 Agreement - Study Phase May 18, 1977 Agreement - Extended May 14, 1972 Summit Agreement</li> </ul>	<p>The May 1 agreement provides for a study of the objectives, feasibility, and means of a possible joint mission using the US Shuttle and the USSR Salyut spacecraft. The Summit Agreement confirmed this effort and other bilateral undertakings in US/USSR space cooperation.</p>
<ul style="list-style-type: none"> <li>Support of Other Agencies' Cooperative Agreements with the USSR in Science and Technology</li> </ul>	<p>NASA has provided technical support to the DOE, FAA and NOAA.</p>
<ul style="list-style-type: none"> <li>o Completed Project</li> <li>• Current</li> </ul>	

## US/China Space Projects

Project and Date	Description
<ul style="list-style-type: none"> <li>1979 Understanding on Cooperation in Space Technology:  Communications/Broadcast Satellite System</li> </ul>	<p>Appended to the US - China Agreement on Cooperation in Science and Technology, signed January 31, 1979.</p> <p>The Understanding expresses China's intention, under suitable conditions, to procure broadcasting satellite and communications system including the associated ground receiving and redistribution equipment from US industry. The space portion of the system is to be launched by NASA.</p>
<p>Landsat-D Ground Station</p>	<p>The Understanding also records China's intention, under suitable conditions, to purchase from US industry a ground station capable of receiving earth resources information from the NASA Landsat remote sensing satellites, including the Landsat now under development.</p>
<ul style="list-style-type: none"> <li>Landsat Memorandum of Understanding</li> </ul>	<p>Signed January 24, 1980, the MOU provides for Chinese participation in the Landsat program and direct reception of Landsat data by the planned Chinese ground station. See page 67 for a fuller description of MOU provisions.</p>
<ul style="list-style-type: none"> <li>Prospective Cooperation in Fundamental Aeronautical Technology</li> </ul>	<p>NASA and the Chinese Aeronautical Establishment (CAE) have exchanged delegations to explore the prospects for cooperation in fundamental aeronautical technology, and intend to work toward agreement on initial cooperative projects in this field.</p>

o Completed Projects  
• Current

NASA INTERNATIONAL PROGRAMS

## Scientific and Technical Information Exchanges

Project and Date	Description
<ul style="list-style-type: none"> <li>NASA/European Space Agency (ESA) Scientific and Technical Information Exchange 1964-present</li> </ul>	<p>Under tripartite agreements with NASA, 505 European organizations submit current technical reports to ESA for pre-processing for inclusion in the NASA data base. In exchange the organizations receive limited on-line access to NASA's Scientific and Technical Aerospace Reports (STAR) and International Aerospace Abstracts (IAA) files on the Information Retrieval Service data base.</p>
<ul style="list-style-type: none"> <li>Bilateral Technical Document Exchange Program 1962-present</li> </ul>	<p>NASA maintains separate technical document exchange programs with 215 organizations in 55 countries* and another 85 organizations receive additional services, primarily copies of the <u>STAR</u>.</p>
<ul style="list-style-type: none"> <li>Korean Institute of Science and Technology (KIST) 1971-1972</li> </ul>	<p>Agency for International Development (AID) initiated an experimental project to test the feasibility of transferring aerospace technology documented in NASA scientific and technical information collection to meet specific Korean economic development needs. This pilot project resulted in a number of transfers in electronics area. An AID-sponsored international workshop to discuss the results of the project was conducted by KIST in Korea in 1972 and in Latin America in 1973.</p>
<ul style="list-style-type: none"> <li>o Completed Project</li> <li>• Current</li> <li>* See Appendix D for list of countries</li> </ul>	

# Launchings of Non-US Spacecraft

Country, Name, Purpose*	Vehicle, Launch Site**, Date	Country, Name, Purpose*	Vehicle, Launch Site**, Date
ARAB SATELLITE COMMUNICATIONS ORGANIZATION			
• Arabsat-A (RC)	Shuttle/1984	FRANCE/GERMANY	Delta/Dec. 17, 1974
• Arabsat-B (RC)	Shuttle/1984	• Symphonie-A (EC)	Delta/Aug. 26, 1975
		• Symphonie-A (EC)	
CANADA		GERMANY	Scout/WTR/Jul. 16, 1974
• Telesat-A (Anik-I) (DC)	Delta/Nov. 9, 1972	• AEROS-B (S)	Shuttle/1982
• Telesat-B (Anik-II) (DC)	Delta/Apr. 20, 1973	• MBB-SPAS-01 (E)	Shuttle/1984
• Telesat-C (Anik-III) (DC)	Delta/May 7, 1975	• Spacelab D1 (SA)	
• Telesat-D (Anik-B) (DC)	Delta/Dec. 16, 1978		
• Telesat-E (Anik-C1) (DC)	Shuttle/1982	INDIA	
• Telesat-F (Anik-D1) (DC)	Shuttle/1983	• Insat-1A (DC,A)	Shuttle/1983
• Telesat-G (Anik-C2) (DC)	Delta/1982	• Insat-1B (DC,A)	Shuttle/1983
• Telesat-I (Anik-C3) (DC)	Shuttle/1984		
• Telesat-H (DC)	Shuttle/1985	INDONESIA	
EUROPEAN SPACE AGENCY (ESA)		• Palapa-A-1 (DC)	Delta/Jul. 8, 1976
• HEOS-1 (S)	Delta/WTR/Dec. 5, 1968	• Palapa-A-2 (DC)	Delta/Mar. 10, 1977
• BOREAS/ESRO 1B (S)	Scout/WTR/Oct. 1, 1969	• Palapa-B-1 (RC)	Shuttle/1984
• HEOS A-2 (S)	Delta/WTR/Jan. 31, 1972	• Palapa-B-2 (RC)	Shuttle/1984
• TD-1 (S)	Delta/WTR/Mar. 12, 1972		
• ESRO IV (S)	Scout/WTR/Nov. 21, 1972	ITALY	
• COS-B (S)	Delta/Aug. 8, 1975	• SIRIO (EC)	Delta/Aug. 25, 1977
• GEOS-A (S)	Delta/Apr. 20, 1977	• IRIS (A)	Shuttle/1985
+ OTS-A (EC)	Delta/Sep. 13, 1977		
• METEOSAT (A)	Delta/Nov. 22, 1977	JAPAN	
• OTS-B (EC)	Delta/May 11, 1978	• GMS (A)	Delta/Jul. 14, 1977
• GEOS-B (S)	Delta/Jul. 14, 1978	• CS (EC)	Delta/Dec. 14, 1977
		• BS (EC)	Delta/Apr. 7, 1978

\*Purpose Code: A - Applications I - International  
C - Communications R - Regional  
D - Domestic S - Scientific  
E - Experimental  
o Launch/launch attempt  
• Scheduled  
+ Desired orbit not achieved

\*\*All launchings from Eastern Test Range (ETR) except where otherwise indicated.

## Launchings of Non-US Spacecraft

Country, Name, Purpose*	Vehicle, Launch Site**, Date	Country, Name, Purpose*	Vehicle, Launch Site**, Date
NATO (via DOD) o NATO A (C) o NATO B (C) o NATO III-A (C) o NATO III-B (C) o NATO III-C (C)	Delta/Mar. 20, 1970 Delta/Feb. 2, 1971 Delta/Apr. 22, 1976 Delta/Jan. 27, 1977 Delta/Nov. 18, 1978	+ Intelsat IV F-6 (IC) o Intelsat IV F-1 (IC) o Intelsat IV-A F-1 (IC) o Intelsat IV-A F-2 (IC) o Intelsat IV-A F-4 (IC) + Intelsat IV-A F-5 (IC) o Intelsat IV-A F-3 (IC) o Intelsat IV-A F-6 (IC) • Intelsat V (IC) • Intelsat V (IC) • Intelsat V (IC) • Intelsat V (IC) • Intelsat V (IC) • Intelsat V (IC) • Intelsat V-A (IC) • Intelsat V-A (IC) • Intelsat V-A (IC)	Atlas C/Feb. 20, 1975 Atlas C/May 22, 1975 Atlas C/Sep. 25, 1975 Atlas C/Jan. 29, 1976 Atlas C/May 26, 1977 Atlas C/Sep. 29, 1977 Atlas C/Jan. 7, 1978 Atlas C/Mar. 31, 1978 Atlas C/Dec. 1980 Atlas C/Mar. 1981 Atlas C/Jun. 1981 Atlas C/Sep. 1981 Atlas C/1981 Atlas C/1981 or Shuttle/1982 Shuttle/1983 Atlas C/1984 or Shuttle/1984 Atlas C/1984 or Shuttle/1985 Atlas C/1984 or Shuttle/1985
UNITED KINGDOM o Skynet-1 (via DOD) (C) + Skynet-2 (via DOD) (C) + Skynet-2A (via DOD) (C) o UK-4 (S) o Skynet-2B (via DOD) (C) o UK-6 (S)	Delta/Nov. 22, 1969 Delta/Aug. 19, 1970 Delta/Jan. 18, 1974 Scout/WTR/Mar. 8, 1974 Delta/Nov. 22, 1974 Scout/Wallops/June 2, 1979		
INTELSAT o Intelsat I F-1 (IC) + Intelsat II F-1 (IC) o Intelsat II F-2 (IC) o Intelsat II F-3 (IC) o Intelsat II F-4 (IC) + Intelsat III F-1 (IC) o Intelsat III F-2 (IC) o Intelsat III F-3 (IC) o Intelsat III F-4 (IC) + Intelsat III F-5 (IC) o Intelsat III F-6 (IC) o Intelsat III F-7 (IC) + Intelsat III F-8 (IC) o Intelsat IV F-2 (IC) o Intelsat IV F-3 (IC) o Intelsat IV F-4 (IC) o Intelsat IV F-5 (IC) o Intelsat IV F-7 (IC) + Intelsat IV F-8 (IC) o Intelsat IV F-8 (IC)	Delta/Apr. 6, 1965 Delta/Oct. 26, 1966 Delta/Jan. 11, 1967 Delta/Mar. 23, 1967 Delta/Sep. 28, 1967 Delta/Sep. 19, 1968 Delta/Dec. 18, 1968 Delta/Feb. 5, 1969 Delta/May 22, 1969 Delta/Jul. 26, 1969 Delta/Jan. 14, 1970 Delta/Apr. 22, 1970 Delta/Jul. 23, 1970 Atlas C/Jan. 25, 1971 Atlas C/Dec. 19, 1971 Atlas C/Jan. 22, 1972 Atlas C/Jun. 13, 1972 Atlas C/Aug. 23, 1973 Atlas C/Nov. 21, 1974		
FOREIGN LAUNCHINGS OF NASA SPACECRAFT			
ITALY o SAS-A (Explorer-42) (S) o SAS-A (Explorer-45) (S) o SAS-B (Explorer-48) (S) o SAS-C (Explorer-53) (S)			Scout, San Marco, Dec. 12, 1970 Scout, San Marco, Nov. 15, 1971 Scout, San Marco, Nov. 16, 1972 Scout, San Marco, May 7, 1975

## NASA Overseas Tracking Stations/Facilities

Country/Site	Date of Agreement/ or Operational Date	Date Deactivated	Country/Site	Date of Agreement/ or Operational Date	Date Deactivated
ARGENTINA o Mar del Plata (tracking ship Vanguard) (STDN)	1973	1974	CUBA o Havana	Acquired when NASA formed	Jan. 1959
AUSTRALIA o Carnarvon (STDN) o Darwin (OG0) • Deakin-NASCOM • Switching Center (STDN) • Honeysuckle Creek (DSN) o Muchea (MSFN) • Orroral Valley (STDN) • Tidbinbilla (DSN) o Toowoomba (ATS) o Woomera (MSFN) o Woomera (DSN) o Woomera (Minitrack) • Yarragadee (Mobile Laser STDN-UHF)	Feb. 11, 1963 Feb. 26, 1960 Feb. 11, 1963 Feb. 11, 1963 Feb. 11, 1963 Feb. 26, 1960 Oct. 22, 1963 Oct. 22, 1963 Dec. 7, 1965 1960 Feb. 26, 1960 Aug. 1957 Jun. 27, 1978	Dec. 1974 1968 Still active Still active Mar. 1964 Still active Still active Jun. 1970 1963 Dec. 1972 1966 Still active	ECUADOR • Quito (STDN) INDIA o Ahmedabad MADAGASCAR o Antananarivo (STDN) o Majunga MEXICO o Guaymas (MSFN) NIGERIA o Kano (MSFN) PAKISTAN o Rawalpindi (Portable Landsat Receiver) PERU o Lima (STADAN) SEYCHELLES o Mahe (STDN)	Feb. 24, 1960 1962 Oct. 7, 1963 1963 Apr. 12, 1960 Oct. 19, 1960 Aug. 1975 Mar. 6, 1959 (Became operational Aug. 1956) Dec. 30, 1966	Still active 1962 Jul. 1975 1964 Jan. 1971 Dec. 1967 Sep. 1977 1970 1977
BOTSWANA • Gaborone BRAZIL o Brasilia CANADA o St. John's, Newfoundland (STDN) CHILE o Antofagasta (STADAN) • Santiago (STDN)	1981 1962 Aug. 24, 1960 Dec. 20, 1971 Feb. 23, 1972 Nov. 15, 1956 Feb. 19, 1959	Active 1963 Aug. 1970 Aug. 1973 1976 Jul. 1963 Still active			

- o Deactivated
- Operational

## NASA Overseas Tracking Stations/Facilities

Country/Site	Date of Agreement/ or Operational Date	Date Deactivated	Country/Site	Date of Agreement/ or Operational Date	Date Deactivated
SPAIN					
o Canary Islands (STDN)					
• Fresnedillas - Navalagamella (STDN)	Apr. 1966	Still active			
• Robledo I (DSN)	Jul. 1965	Still active			
• Cebreros (DSN)	Jan. 1967	Still active			
• Robledo II (DSN)	Sep. 1973	Still active			
• NASCOM switching center	Jul. 1965	Still active			
o Madrid (ATS-6)	May 1975	Sep. 1976			
SOUTH AFRICA					
o Johannesburg	Sep. 13, 1960	(DSN) Jun. 1974 (STDN) Oct. 1975			
TANZANIA					
o Zanzibar Island	Oct. 14, 1960	Jul. 1964			
UNITED KINGDOM					
o Antigua (STDN)	Jan. 23, 1967	1973			
o Antigua (Minitrack)	Installed Oct. 1956	1961			
• Ascension Island (STDN)	Jun. 26, 1956	Still active			
• Bermuda (STDN)	Mar. 15, 1961	Still active			
o Canton Island (MSFN)	Apr. 6, 1961	Dec. 1967			
o Grand Bahama (MSFN)	May 3, 1968	1971			
o Grand Turk (MSFN)	Acquired when NASA formed	Jul. 1961			
o Grand Turk (Mobile Laser)	1975	1976			
o Grand Turk (Mobile Laser)	1978	1978			
o Winkfield (STDN)	Jan. 1, 1967	Sep. 30, 1980			

## NASA Funded SAO Optical and Laser Tracking Facilities

Country/Site	Operational Date	Deactivation Date	Country/Site	Operational Date	Deactivation Date
ARGENTINA o Villa Dolores o Comodoro Rivadavia	Jul. 1958 Nov. 1966	Oct. 1966 Jan. 1970	NETHERLANDS ANTILLES o Curacao	Jun. 1958	Jul. 1966
AUSTRALIA o Woomera o Island Lagoon ● Orroral Valley	Mar. 1958 Jul. 1964 1976	Jun. 1964 Apr. 1973 Laser - Still Active	PERU ● Arequipa	Jul. 1958	Laser - Still Active
BRAZIL ● Natal o San Paulo	Sep. 1966 Unknown	Laser - Still Active 1977	SENEGAL o Dakar	Dec. 1970	Sep. 1971
CANADA o St. Margaret's, New Brunswick	Aug. 1976	Jun. 1978*	SOUTH AFRICA o Olifantsfontein	Mar. 1958	Sep. 1975
ETHIOPIA o Addis Ababa	Aug. 1966	Aug. 1976	SPAIN o San Fernando	Mar. 1958	Jun. 1978*
GREECE o Dionysos	Dec. 1967	Jun. 1978*	UPPER VOLTA o Ouagadougou	May 1972	Nov. 1975
INDIA o Naini Tal	Aug. 1958	Jun. 1978*			
IRAN o Shiraz	May 1958	Jul. 1966			
JAPAN o Tokyo o Dodaïra	Apr. 1958 May 1968	May 1968 Jun. 1978*			

\*Terminated NASA funding. Continues as local operation.

o Deactivated  
● Operational

NASA INTERNATIONAL PROGRAMS

## Reimbursable Tracking Arrangements

Country/Spacecraft	Date	Country/Spacecraft	Date	Country/Spacecraft	Date
SUPPORT PROVIDED BY NASA		SUPPORT PROVIDED BY NASA (Continued)		SUPPORT RECEIVED BY NASA	
EUROPEAN SPACE AGENCY (ESA)		JAPAN		FRANCE	
• Ariane 1-4	1979-81	o Ohsumi	1970	o Explorer-42 (SAS-1)	1970-74
• Ariane 5-8	1981-83	o MS-T-1 (Tansei-1)	1971	o Syncom 3	1971
• Meteosat II	1981	o MS-F2 (Shinsei)	1971	o San Marco 3	1971
• Exosat	1981	o REXS (Denpa)	1972	o Explorer-48 (SAS-2)	1972-74
FRANCE		o MS-T2 (Tansei-2)	1974	o Explorer-53 (SAS-3)	1975-76
o A-1	1965	o SRATS (Taiyo)	1975	ITALY	
o D-1A	1966	o ETS-1 (KiKu-1)	1975	o Explorer-42 (SAS-1)	1970
o DIADEME-1	1967	o CORSA-A	1976	o Explorer-53 (SAS-3)	1975
o DIADEME-2	1967	o ISS-1 (UME)	1976	o TIROS-N	1978
o PEOLE	1970-73	o MS-T3 (Tansei-3)	1977	o NOAA-A	1978-79
o D2-A (Tournesol)	1971-74	o ETS-2 (KiKu-2)	1977	UNITED KINGDOM	
o SRET-1	1972	o EXOS-A (Kyokko)	1978	(Includes Singapore and Falkland Islands)	
o D5-A (POLLUX)	1973-75	o ISS-2 (UME-2)	1978	o UK 1,2	1963-70
o D5-B (CASTOR)	1973-79	o EXOS-B	1978	o Alouette	1963-71
o STARLETTE	1975-78	o CORSA-B	1979	o Explorer-42 (SAS-1)	1970
o SRET-2	1975-78	o ECS-A	1979		
o D2-B	1975-77	o ECS-B	1980		
o SIGNE III	1977-78	o MS-T4 (Tansei 4)	1980		
• Telecom 1	1982	• GMS-2	1981		
• Telecom 2	1983	• ASTRO-A	1981		
• SPOT	1984	• ETS-III	1982		
FRANCE/GERMANY		UNITED KINGDOM			
o DIAL-WIKA	1970	• UK-6	1979-81		

o Completed Support  
• Current Support

## Personnel Exchanges

Program	Purpose	Participation	
		Current	Cumulative
Resident Research Associateships	Postdoctoral and senior postdoctoral grants are provided for senior foreign scientists. The program, administered for NASA by the National Academy of Sciences, provides for participation in research at NASA centers and the Jet Propulsion Laboratory (JPL) for one year.	Foreign Nationals from Countries 100	1,151
International Fellowships	Theoretical and experimental training in the space sciences is provided on a cost sharing basis to foreign graduate students at United States (US) universities for one year with the possibility of renewal for a second year. This program, which was terminated in 1976, was administered for NASA by the National Academy of Sciences and designed to contribute to the capabilities of cooperating countries.	Fellows from Countries/Universities 22	45
Technical Training at NASA Centers	Technical training can be arranged for foreign scientific and technical personnel at NASA centers in support of agreed cooperative programs and ground facility operations. The length of training may vary from several months to one year.	Foreign Nationals from Countries or Organizations 22	955
Foreign Visitors	Officials and scientists from foreign countries/organizations visit NASA facilities in programs demonstrating the open, peaceful character of the US civilian space effort and the opportunities it provides for participation by other countries.	Visitors from Countries or Organizations 4,490	75,890
			57* 128**

\*Includes European Space Agency (ESA).

\*\*See following page for additional information.

NASA INTERNATIONAL PROGRAMS

## Personnel Exchanges

### Foreign Visitors to NASA Facilities\*

Afghanistan	Finland*	Libya	Somalia
Algeria	France*	Luxembourg*	South Africa*
Argentina*	Gabon*	Madagascar	Spain*
Australia*	Gambia	Malawi	Sri Lanka
Austria*	German Democratic Republic	Malaysia*	Sudan
Bahamas	Germany, Federal Republic of*	Mali*	Swaziland
Bangladesh*	Ghana	Malta	Sweden*
Barbados	Greece	Mauritania*	Switzerland*
Belgium*	Guatemala	Mauritius*	Syria*
Benin	Guinea	Mexico*	Tanzania
Bolivia	Guyana	Monaco	Thailand
Botswana*	Haiti	Morocco*	Togo
Brazil	Honduras	Nepal	Trinidad and Tobago
Bulgaria*	Hungary*	Netherlands*	Tunisia
Burma	Iceland*	New Zealand*	Turkey
Burundi	India*	Nicaragua*	Uganda
Cameroon	Indonesia*	Niger	Union of Soviet Socialist Republics*
Canada*	Iran	Nigeria	Latvia
Central African Republic	Iraq	Norway*	Lithuania
Chad	Ireland	Pakistan*	United Arab Emirates
Chile*	Israel*	Panama	United Kingdom*
China*	Italy*	Paraguay	Bermuda
mainland	Ivory Coast	Peru	Hong Kong
Taiwan	Jamaica	Philippines*	Upper Volta*
Colombia*	Japan*	Poland*	Uruguay
Costa Rica*	Jordan	Portugal	Venezuela*
Cyprus	Kenya	Rhodesia	Vietnam, Republic of
Czechoslovakia*	Korea, Republic of*	Romania*	Yemen
Denmark*	Kuwait	Rwanda	Yugoslavia*
Dominican Republic	Laos	Saudi Arabia*	Zaire
Ecuador*	Lebanon	Senegal*	Zambia*
Egypt*	Lesotho	Sierra Leone	
El Salvador	Liberia	Singapore	
Ethiopia			
European Space Agency*			

\*Indicates visits during calendar year 1980

## APPENDIX A: Abbreviations and Acronyms

<u>A</u>			
AAP	Apollo Applications Program	ATS	Applications Technology Satellite
ADOD	Australian Department of Defense	AU	Astronomical Unit
ADOS	Australian Department of Science	AXAF	Advanced X-Ray Astrophysics Facility
AE	Atmospheric Explorer		<u>B</u>
AES	Atmospheric Environment Service, Canada	BCS	Boost Control System
AID	Agency for International Development, US	BIOSACK	Biological Effects of Cosmic Radiation (Heavy Nuclei) Experiment
AIDSAT	AID Sponsored International Applications Demonstration	BMBW	Federal Ministry for Education and Science, Germany
AIRO	NASA Airborne Infrared Observatory	BMFT	Federal Ministry for Research and Technology, Germany
ALADDIN	Atmospheric Layering and Density Distribution of Ions and Neutrals	BMWF	Federal Ministry for Scientific Research, Germany
ALSEP	Apollo Lunar Surface Experiments Package	BNCSS	British National Committee for Space Research
ANS	Astronomical Netherlands Satellite	BSE	Broadcast Satellite Experiment, Japan
APT	Automatic Picture Transmission	BUSS	Balloon Borne Ultraviolet Spectrophotometer
ARC	NASA Ames Research Center		<u>C</u>
ARGOS	French Satellite Data Collection System on TIROS-N	CalTech	California Institute of Technology
ARIA	Advanced Range Instrumented Aircraft Simulation	CAE	Chinese Aeronautical Establishment
ASTP	Apollo-Soyuz Test Project	CAS	Chinese Academy of Sciences
		CCRS	Canada Centre for Remote Sensing
		CDS	Center for Stellar Data, France

CDS	Center for Stellar Data, France	Co-PI	Co-Principal Investigator
CEC	Commission of European Communities	COSPAR	Committee on Space Research, ICSU
CENS	Center for Nuclear Studies, France	COSPAS	Space Project Searching For Vessels and Aircraft in Distress
CENTO	Central Treaty Organization	CRA	Center for Aerospace Research, University of Rome, Italy
CESR	Center for Space Studies of Radiation, France	CRC	DOC Communications Research Centre, Canada; formerly DRTÉ
CNAE	National Commission for Space Research, Brazil; now INPE	CSIR	Council for Scientific and Industrial Research, South Africa
CNES	National Center for Space Studies, France	CSIRO	Commonwealth Scientific and Industrial Research Organization, Australia
CNET	National Center for Telecommunications Studies, France	CS	Communications Satellite, Japan
CNIE	National Commission for Space Research, Argentina	CTS	Communications Technology Satellite
CNPq	National Council on Scientific and Technological Development, Brazil	CZCS	Coastal Zone Color Scanner
CNR	National Research Council, Italy		D
CNRS	National Center for Scientific Research, France	DAE	Department of Atomic Energy, India
COBAE	Commission for Space Activities, Brazil	DCIEM	Defense and Civil Institute of Environmental Medicine, Canada
Co-I	Co-Investigator	DEMR	Department of Energy, Mines, and Resources, Canada
CONEE	National Commission on Outer Space, Mexico	DFRC	NASA Dryden Flight Research Center
CONIE	National Space Research Commission, Spain	DFVLR	German Aerospace Research and Test Establishment
COPERNICUS	Alternate name for OAO-3 satellite.		

DITC	Department of Industry, Trade, and Commerce, Canada	ESA	European Space Agency; formerly ESRO
D0C	Department of Communications, Canada	ESDAC	European Space Data Center, Germany; now ESOC
D0D	Department of Defense, US	ESOC	European Space Operations Center, Germany
D0E	Department of Energy, US	ESRIN	European Space Research Institute, Italy
D0S	Department of Space, India	ESRO	European Space Research Organization; now ESA
DRA	Danish Research Administration	ESTEC	European Space Technology Center, Netherlands
DRB	Defense Research Board, Canada	ETR	Eastern Test Range; includes both Patrick Air Force Base and Cape Canaveral, Florida
DRTE	Defense Research Telecommunications Establishment, Canada; now CRC	EUV	Extreme Ultraviolet
DSC	Data Collection System	EXAMETNET	Experimental Inter-American Meteorological Rocket Network
DSN	Deep Space Network, NASA		
DSRI	Danish Space Research Institute	<u>E</u>	
		FAA	Federal Aviation Administration, US Dept. of Transportation
EASEP	Early Apollo Surface Experiments Package	FAO	Food and Agriculture Organization, UN
Eole	US/French Meteorological Satellite/Balloon Project	FAUST	Far UV Space Telescope
EPA	Environmental Protection Agency, US	FGGE	First GARP Global Experiment
ERBE	Earth Radiation Budget Experiment	FRG	Federal Republic of Germany
EREP	Earth Resources Experiment Package, Skylab	<u>G</u>	
ERTS	Earth Resources Technology Satellite; now Landsat	GARP	Global Atmospheric Research Program

GASP	Global Air Sampling Program	ICSU	International Council of Scientific Unions
GATE	GARP Atlantic Tropical Experiment	IES	Ionospheric Explorer Satellite
GDR	German Democratic Republic	IGP	Geophysical Institute of Peru
GEOS	Geodetic Earth Orbiting Satellite (Kupin)	IGY	International Geophysical Year
GEOS	Geodynamic Experimental Ocean Satellite (GEOS 1 & 2)	IMP	Interplanetary Monitoring Platform
GEOS	ESA Geostationary Scientific Satellite	INCOSPAR	Indian National Committee for Space Research
GfW	German Space Research Corporation	INPE	Institute of Space Research, Brazil; formerly CNAE
GISS	Goddard Institute for Space Studies	INTA	National Institute for Aerospace Technology, Spain
GSFC	NASA Goddard Space Flight Center	INTELSAT	International Telecommunications Satellite Organization
GWE	Global Weather Experiment	IPW	Institute for Space Physics Research, Germany
	<u>H</u>	IR	Infrared
HALOE	Halogen Occultation Experiment	IRAS	US/Netherlands Cooperative Infrared Astronomical Satellite
HCMM	Heat Capacity Mapping Mission	IRIS	International Radiation Investigation Satellite
HEAO	High Energy Astronomical Observatory	IRLS	Interrogation Recording and Location System
Helios	US/Germany Solar Probe	ISAGEX	International Satellite Goedsy Experiment
HEOS	European Highly Eccentric Orbit Satellite	ISAS	Institute of Space and Aeronautical Science, University of Tokyo, Japan
	<u>I</u>	ISC	Italian Space Commission
IAA	International Aerospace Abstracts		
IAF	International Astronautical Federation		

ISEE	US/ESA Cooperative International Sun-Earth Explorer		
ISIS	US/Canadian International Satellite for Ionospheric Studies	LACIE	Large Area Crop Inventory Experiment
ISPM	International Solar Polar Mission	LAGEOS	Laser Geodynamic Satellite
ISRO	Indian Space Research Organization; formerly part of DAE; now part of DOS	Landsat	Land Satellite for Remote Sensing; formerly ERTS
ITU	International Telecommunications Union	LaRC	NASA Langley Research Center
IUE	International Ultraviolet Explorer Satellite	LAS	Laboratory for Space Astronomy, CNRS, France
IUS	Inertial Upper Stage	LDEF	Long Duration Exposure Facility
	<u>J</u>	LeRC	NASA Lewis Research Center
JOP	Jupiter Orbiter Probe; now Project Galileo	LIMS	Nimbus-7 Limb Infrared Monitor of the Stratosphere
JPL	Jet Propulsion Laboratory, CalTech	LPSP	Laboratory of Stellar and Planetary Physics, CNRS, France
JRC	Joint Research Center, CEC	LRO	Laboratory for Space Research, Netherlands
JSC	NASA Johnson Space Center, formerly Manned Spacecraft Center	LURE	Lunar Laser Ranging Experiment
	<u>K</u>	Luster	Lunar and Extraterrestrial Dust Analysis Project
KeV	Kilo-Electron Volt		<u>M</u>
KIST	Korean Institute of Science and Technology	Magsat	Magnetic Field Satellite
KSC	NASA Kennedy Space Center	MAROTS	Maritime Orbital Test Satellite, ESA
		MIT	Massachusetts Institute of Technology
		MOD(PE)-RAE	Ministry of Defense (Procurement Executive)-Royal Aircraft Establishment

MMS	Multimission Modular Spacecraft	Nimbus	US Series of Experimental Meteorological Satellites
MN	National Meteorology Agency, France	NIVR	Netherlands Agency for Aerospace Programs
MPI	Max Planck Institute, Germany	NLR	National Aerospace Laboratory, Netherlands
MSC	Manned Spacecraft Center; now NASA Johnson Space Center	NOAA	National Oceanic and Atmospheric Administration, US Department of Commerce
MSFC	NASA Marshall Space Flight Center	NPL	National Physical Laboratory, India
MSFN	Manned Space Flight Network, NASA	NRCC	National Research Council of Canada
MOU	Memorandum of Understanding	NRCT	National Research Council of Thailand
	<u>N</u>	NSF	National Science Foundation, US
NACA	National Advisory Committee for Aeronautics; predecessor of NASA	NSRC	National Space Research Committee, New Zealand
NAS	National Academy of Science, US	NSSDC	National Space Science Data Center, US
Nascom	NASA Communications	NTNF	Norwegian Council for Scientific and Industrial Research
NASDA	National Space Development Agency, Japan		<u>O</u>
NATO	North Atlantic Treaty Organization	OAO	Orbiting Astronomical Observatory
NCAR	National Center for Atmospheric Research, NOAA, US	OGO	Orbiting Geophysical Observatory
NCSR	Norwegian Committee for Space Research	ONERA	National Office for Aerospace Studies and Research, France
NDRE	Norwegian Defense Research Establishment		
NGSP	National Geodetic Satellite Program, US	OPEN	Origin of Plasma in the Earth's Neighborhood

OSO Orbiting Solar Observatory

P\_

PAGEOS Passive Geodetic Earth Orbiting Satellite

Palapa Indonesian Domestic Communications Satellites

PCA Polar Cap Absorption

PI Principal Investigator

PLACE Position Location and Aircraft Communication Experiment

PRL Physical Research Laboratory, India

R\_

RAE Radio Astronomy Explorer Satellite

RAMS Nimbus-7 Random Access Measurement System

RECON Remote Console, NASA Scientific and Technical Information System

RF Radio Frequency

RFI Radio Frequency Interference

RMS Space Shuttle-Attached Remote Manipulator System

RPM Retro-Propulsion Module, Project Galileo

RRL Radio Research Laboratory, Japan

S\_

SACI Advanced Satellite for Interdisciplinary Communications, Brazil

SAGE Stratospheric Aerosol and Gas Experiment

"San Marco" US-Italian Satellite Program for Atmospheric Density Measurement

SAO Smithsonian Astrophysical Observatory

SARSAT Satellite-Aided Search and Rescue Demonstration

SAS Small Astronomy Satellite

SBSA Swedish Board for Space Activities

SCSR Swiss Committee for Space Research

Seasat NASA Experimental Ocean Monitoring Satellite

SEOS Synchronous Earth Observatory Satellite

SEPAC Space Experiments With Particle Accelerators

SHF Super High Frequency

SITE US/Indian Satellite Instructional Television Experiment

SMM Solar Maximum Mission

SMS Synchronous Meteorological Satellite

Soviet Academy Academy of Sciences, USSR

SP	Special Publication, NASA		
SRC	Science Research Council, UK	TDRSS	<u>T</u> Tracking and Data Relay Satellite System
SRL	Space Research Laboratory, University of Utrecht, the Netherlands	TIFR	Tata Institute of Fundamental Research, India
SS	Space Shuttle	TIROS	US Polar Orbiting Meteorological Satellite
SSC	Swedish Space Corporation	TMA	Trimethyl Aluminum
SSRC	Swedish Space Research Committee	TWT	Traveling Wave Tube
SSS	Small Scientific Satellite		<u>U</u>
SSUS	Spinning Solid Upper Stage	UARS	Upper Atmosphere Research Satellites
ST	Space Telescope	UHF	Ultra High Frequency
STADAN	Spaceflight Tracking and Data Acquisition Network, NASA; now STDN	uhuru	Explorer-42; also christened "uhuru," which means "freedom" in Swahili.
STAR	Scientific and Technical Aerospace Reports, NASA	UK	United Kingdom
STARLETTE	French Geodetic Satellite	UN	United Nations
STDN	Space Tracking and Data Network, NASA; formerly STADAN	US	United States
STOL	Short Take-Off and Landing	USSR	Union of Soviet Socialist Republics
STS	Space Transportation System	UV	Ultraviolet
SUPARCO	Space and Upper Atmosphere Research Committee, Pakistan	VAFB	Vandenberg Air Force Base, California
Syncom	Synchronous Communications Satellite	VHF	Very High Frequency
		VLBI	Very Long Baseline Interferometry
			<u>V</u>

VLF	Very Low Frequency
V/STOL	Vertical/Short Take-Off and Landing
	<u>W</u>
WMO	World Meteorological Organization
WTR	Western Test Range, VAFB, California
	<u>X</u>
XTM	Extraterrestrial Materials

# **APPENDIX B:** **International Participation in NASA's Earth** **Resources Investigations Programs**

Argentina (1), (3)	France (1), (2), (3)	Netherlands (1), (3)
Australia (1), (2), (3)	Germany, Federal Republic of (1), (2), (3)	New Zealand (2)
Bangladesh (1), (2)	Greece (1)	Norway (1), (2)
Belgium (1)	Guatemala (1)	Pakistan (2)
Bolivia (1), (2), (3)	India (1)	Peru (1), (2)
Botswana (1)	Indonesia (1)	Philippines (1)
Brazil (1), (2), (3)	Iran (1), (2), (3)	Romania (2)
Canada (1), (2), (3)	Israel (1), (3)	South Africa (1), (2)
Central Treaty Organization (CENTO)* (2)	Italy (1), (2), (3)	Spain (1), (2)
Chile (1), (3)	Japan (1), (2), (3)	Sri Lanka (2)
Colombia (1)	Kenya (1), (2)	Sweden (1), (2)
Commission of European Communities (CEC)* (2)	Korea (1), (2)	Switzerland (1), (2), (3)
Ecuador (1)	Lesotho (1)	Thailand (1), (2), (3)
Egypt (2)	Libya (2)	Turkey (2)
Finland (1), (2)	Malaysia (1), (2)	United Kingdom (1), (2), (3)
Food & Agriculture Organization (FAO), UN*	Mali (1), (3)	Venezuela (1), (3)
(1), (2), (3)	Mekong Commission* (1), (2)	
	Mexico (1), (2), (3)	

(1) Landsat 1 1972-1975  
 (2) Landsat 2 1975-1978  
 (3) Skylab Earth Resources Experiment Package (EREP) Investigations 1973-1976

\*Indicates International Organization

## APPENDIX C:

### Locations of APT Stations

Automatic Picture Transmission (APT) capabilities are built into all operational meteorological satellites that are developed by NASA for the National Oceanic and Atmospheric Administration (NOAA). These satellites are launched by NASA but once in orbit became the operational responsibility of NOAA. Receiving station technology, developed at the NASA Goddard Space Flight Center (GSFC), is made available to anyone wishing to make a modest investment to obtain real-time local cloud cover images. APT stations may be purchased commercially and range in price from \$20K-\$50K. However, many countries have made substantially higher investments in APT. The locations of APT stations are given below:

Afghanistan	El Salvador	Kenya
Algeria	Ethiopia	Korea, Republic of
Angola*	Fiji	Kuwait
Antarctica (US Naval Research)	Finland	Madagascar
Argentina	France <sup>1</sup>	Malaysia
Australia	French Guiana	Mali
Austria	Guadeloupe, FWI	Malta
Bahamas	Martinique, FWI	Mauritania
Bahrain	Tahiti, FWI	Mauritius
Bangladesh	Gambia	Mexico
Barbados	Germany, (FRG) <sup>1</sup>	Mongolia
Belgium <sup>1</sup>	Germany, (GDR)	Morocco
Bolivia	Ghana	Mozambique
Brazil <sup>1</sup>	Guatemala	Nepal
Bulgaria	Guyana	Netherlands
Burma	Honduras	Curacao
Cambodia	Hong Kong	Netherlands Antilles
Cameroon	Hungary	New Zealand <sup>1</sup>
Canada <sup>1</sup>	Iceland	Nicaragua
China	India <sup>1</sup>	Nigeria
mainland <sup>1</sup>	Indonesia	Norway <sup>1</sup>
Taiwan	Iran* <sup>1</sup>	Oman
Chile	Iraq	Pakistan
Colombia	Israel	Papua New Guinea
Czechoslovakia	Italy	Paraguay
Dominican Republic	Ivory Coast	Peru
Ecuador	Japan	Philippines
Egypt	Jordan	Poland

\*Status unknown

<sup>1</sup>Locations with High Resolution Picture Transmission (HRPT) capability.

Portugal <sup>1</sup>	Sudan	United Kingdom <sup>1</sup>
Azores	Suriname	Bermuda
Romania	Sweden <sup>1</sup>	Scotland
Saudi Arabia <sup>1</sup>	Switzerland	Upper Volta
Senegal	Syria	Uruguay
Seychelles	Tanzania	Venezuela
Sierra Leone	Thailand	Vietnam*
Singapore	Trinidad and Tobago	Yemen, Arab Republic of <sup>1</sup>
Somalia	Tunisia	Yugoslavia
South Africa	Turkey	Zaire
Spain	Union of Soviet Socialist Republics <sup>1</sup>	Zambia
Canary Islands	United Arab Emirates	Zimbabwe
Sri Lanka		

\*Status unknown

<sup>1</sup>Locations with High Resolution Picture Transmission (HRPT) capability.

# **APPENDIX D:** **Countries With Which NASA has Scientific and Technical** **Information Exchange Agreements**

*Argentina	*Germany (FRG)	*Morocco	*Vatican City
*Australia	*Ghana	*Netherlands	Venezuela
*Austria	*Greece	*New Zealand	*Yugoslavia
*Belgium	Guatemala	*Nigeria	Zaire
*Brazil	Haiti	*Norway	
*Bolivia	*Iceland	*Pakistan	
*Bulgaria	*India	*Papua New Guinea	
Burma	*Indonesia	*Peru	
*Canada	*Iran	*Philippines	
*Chile	Iraq	*Poland	
China	*Ireland	*Portugal	
Taiwan	*Israel	*Romania	
*Colombia	*Italy	*Spain	
Costa Rica	*Japan	*South Africa	
*Czechoslovakia	*Kenya	*Sri Lanka	
*Denmark	*Korea, Republic of	*Switzerland	
*Ecuador	Lebanon	*Sweden	
*Egypt	Libya	*Thailand	
El Salvador	Luxembourg	*Turkey	
*Ethiopia	Madagascar	*United Kingdom	
*Finland	Malaysia	Uruguay	
*France	*Mexico	*USSR	

\* Currently active

## NASA International Activities Summary

[illegible]ASA INTERNATIONAL PROGRAMS  
THROUGH JANUARY 1, 1981

☒ CURRENT  
☐ COMPLETED PROJECT OR DISCONTINUED ACTIVITY  
☒ AID/AT DEMONSTRATIONS  
☒ APT STATIONS